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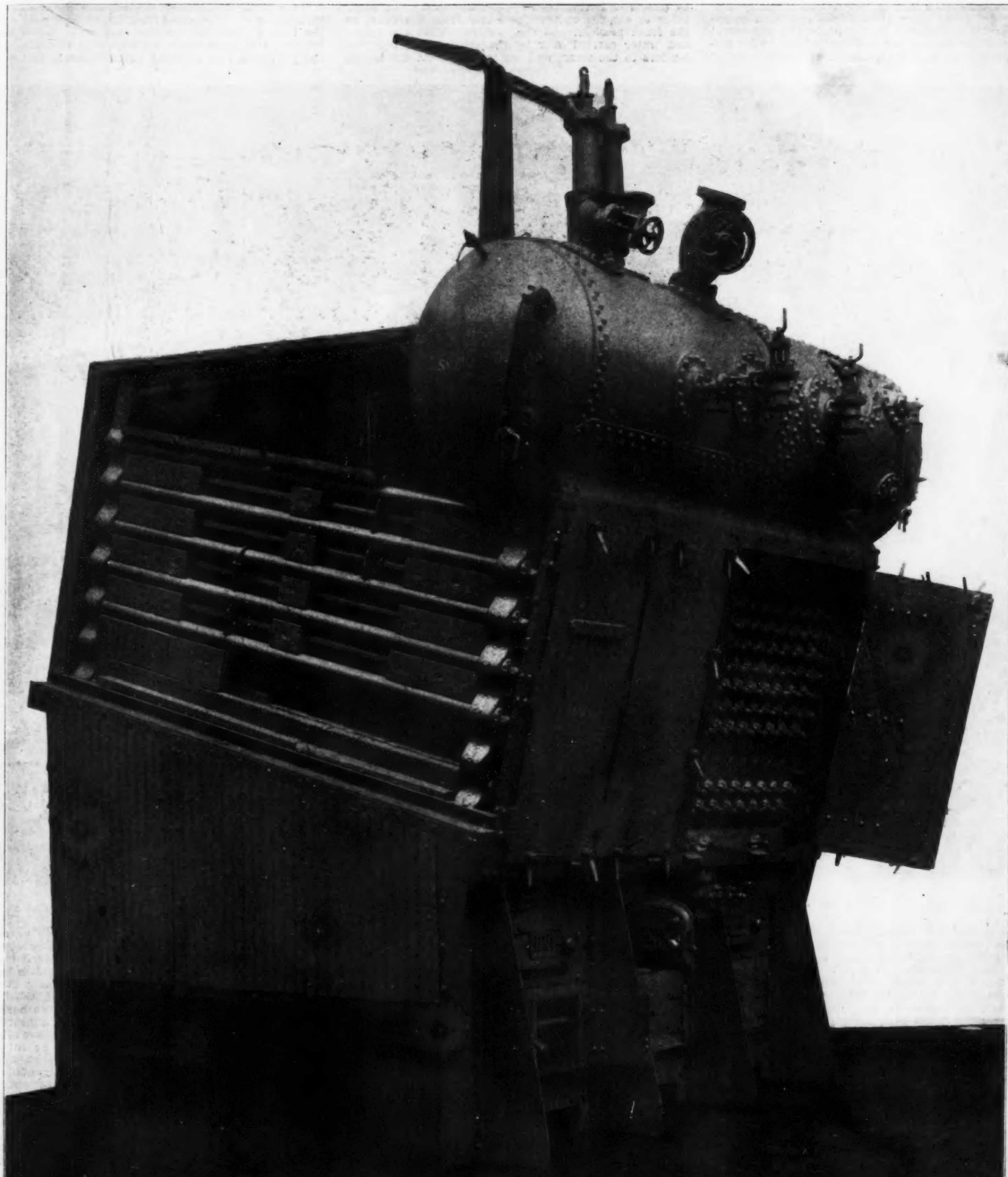


A VIEW OF A BABCOCK-WILCOX MARINE BOILER, SHOWING TUBES AND BAFFLES.

WATER TUBE BOILERS.—IV.

By the English Correspondent of the Scientific American.

THE BABCOCK AND WILCOX WATER TUBE BOILER.

The Babcock and Wilcox water tube boiler is probably more familiar to users of steam in America than any other boiler. Our marine engineers are certainly more closely acquainted with it, since it has proved most successful in our naval vessels, including some thirty of all types, from the battleship "Nebraska," developing 19,000 I.H.P., and the first-class cruisers "California" and "South Dakota," each developing 23,000 I.H.P., to the smaller craft. The introduction of this boiler into the American navy was principally due to the favorable comments expressed upon it by Admiral Melville, who based his report upon the magnificent performance of the gunboat "Marietta" during the Spanish-American war. This vessel on one occasion steamed 12,000 miles without having to stop for any purpose whatever, except coaling, and proceeded almost immediately afterward upon active service. The importance of this achievement can scarcely be overestimated, since it was not a test specially prepared under advantageous conditions and with everything carefully prepared to facilitate the successful working of the boilers, but was carried out under actual war service. The achievement of the "Marietta" was not an isolated instance either, since the cruiser "Chicago," which is fitted with a combination of Babcock and Wilcox water tube and Scotch boilers, has been equally successful. In view of these striking achievements, our Naval Department resolved upon a more extensive utilization of the Babcock and Wilcox boiler. Although it has not engaged in such extensive experiments with the various types of water tube boilers as other nations, more especially Great Britain, the selection appears to be a wise one, since the British Admiralty have installed the Babcock and Wilcox boiler upon several of the more recent vessels, and it has proved a highly efficient boiler for all-round purposes.

The utilization of this boiler for marine work is comparatively recent. It was originally designed for stationary purposes, and as such is now universally employed in Great Britain, and has been introduced into a large number of stations in this country. Owing to its high efficiency and remarkable immunity from derangement, its economy, and safety for stationary purposes it was adapted to marine work.

This boiler differs widely from either of the well-known types as exemplified by the Thornycroft and Yarrow boilers already described. In this instance there is a drum placed horizontally at the top, with feed pipes leading from the front end of the drum to the nest of tubes below, at an inclined angle, and connected at the rear end of the drum with similar tubes which convey the steam into the drum. The general arrangement of the boiler can be more comprehensively gathered by reference to the illustrations Figs. 1 and 2. The boiler comprises a horizontal steam and water drum; inclined tubes forming the bulk of the heating surface; a "mud drum," and a furnace space placed underneath the tubes. The tubes are straight, and the boiler belongs to what is known as the sectional class. That is to say, instead of fixing the tubes in large stayed water boxes, involving the erection of the tubular portion of the boiler in one piece, each vertical row of inclined tubes is combined with two water boxes or "headers" to form a section. By means of connections with the steam and water drum at the high ends of these headers, the steam generated in the tubes is liberated and the water supplied to take its place.

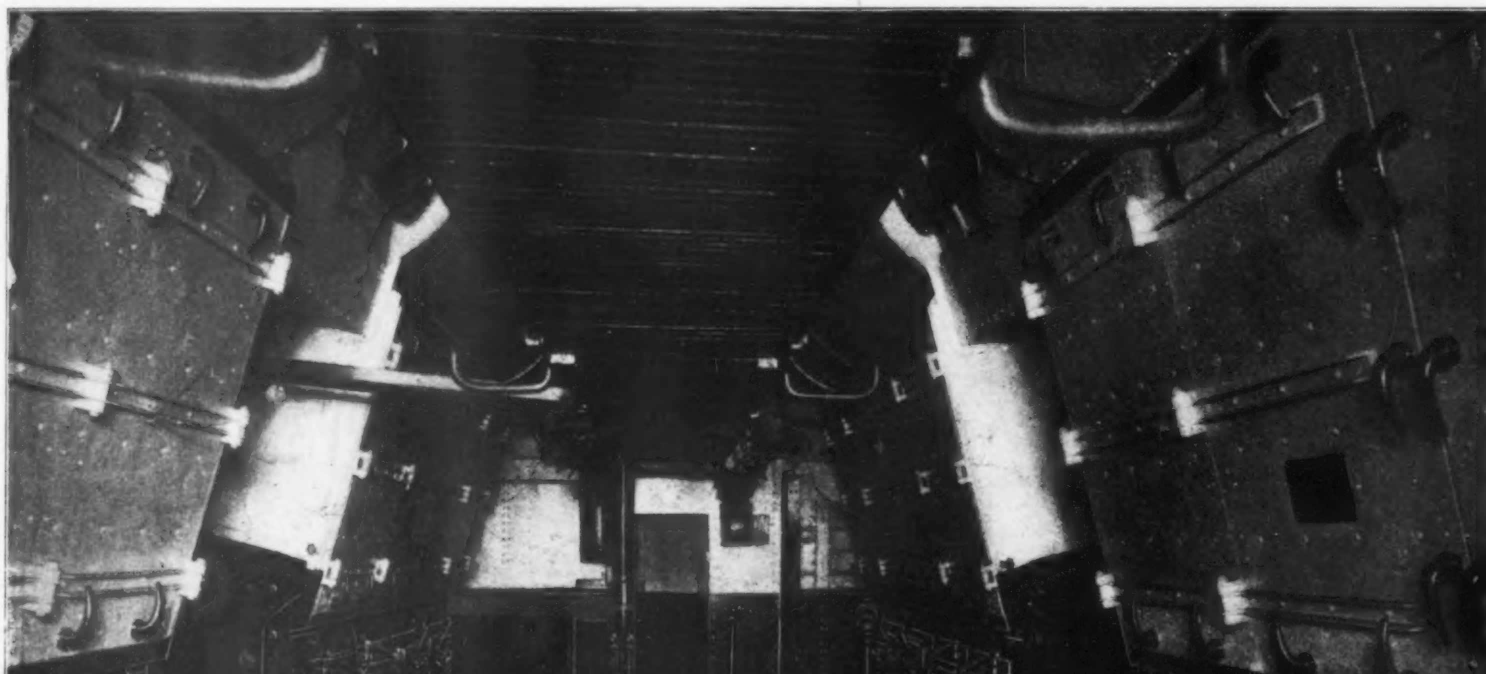
The tubes are made of solid-drawn steel inclined at an angle of 15 deg., rising from the front of the boiler toward the back. The inclined tubes are expanded into wrought steel headers at each end, the top of the front headers being connected with the steam and water drum by short tubes or nipples, and the top of the rear headers with the steam and water drum by means of horizontal or "return" tubes. The short tubes or nipples convey the water from the drum to the front headers, and the "return" tubes the steam and water carried over by the steam from the rear headers to the steam and water drum. At the lowest point underneath the front headers the mud drum is placed.

The header of each section, or vertical row of tubes, is in one piece, and is of such form that the tubes are staggered. That is to say, from the elevation, each section of tubes is of zigzag formation, each row being placed so as to come over the space between the tubes in the row immediately beneath it. By this arrangement the gases from the furnace do not have a straight vertical passage to the chimney, but wend their way in and out round the tubes, so that each receives a quota of heat upon the whole of its external surface. The holes in the header are bored to gage, and the ends of the tubes are expanded thereinto by an expander. The vertical tubes or nipples connecting the section with the steam and water drum are similarly expanded, and the connections with the mud drum are precisely the same, so that there is an entire dispensation of bolts and nuts, thus leaving a clear communication between the various parts. On the outside surface of the header opposite the end of each tube is an opening for the insertion of the brush and scraper for cleaning the tubes, or for examining the tubes and renewing them whenever necessary. These openings are closed by wrought-steel hand-hole doors, the joints of which are made on the inside by means of an asbestos wire-woven joint. The doors are drawn up into place by outside caps and nuts.

The shells of the steam and water drums are made of steel plates double riveted, and the ends of steel plates stamped to shape in a hydraulic press. All the steam mountings, such as stop valves, water gages, safety valves, etc., are attached to the steam and water drum. The blow-out valves are attached to the mud drum. The steam and water drum is further fitted with wash plates to prevent undue movement of the water when the ship is rolling.

In the earlier types of the Babcock and Wilcox boiler, small tubes of 1⅞-inch diameter were employed, but in some of the later designs these small tubes have given way to those of larger diameter—3¼-inch. The smaller size is preferable in cases where the space is limited, or light weight is a great desideratum. The chief advantage of the larger tubes lies in the fact that they can be examined and cleaned more quickly. The adoption of a system of baffling, by which the gases of combustion are made to travel three times over the surface of the tubes, has also resulted in increased economy of fuel consumption, especially with poor classes of fuel and when the boilers are fired by inexperienced or careless stokers.

The furnace doors are placed in the front, and the furnace itself immediately underneath the sections of inclined tubes. The gases from the furnace pass round the tube upward toward the back end, thence down between the tubes again, subsequently returning similarly upward and escaping past the steam and water drum to the chimney. The water in the tubes, as it is heated by the gases of combustion, rises toward the higher end, and as it is partly converted into steam—the mingled column of water and steam being of less specific gravity than the solid water at the rear of the boiler—rises to the top of the rear header, and passes into the drum through the horizontal return tubes, where the steam immediately separates from the water, and the latter flows back again and descends by the short tubes, or nipples, through the front headers into the tubes again, and thus the circulation continues. One advantage of this system is the rapidity and constancy of the circulation. The passages connecting the various portions of the boiler are large, and communication is not impeded in any way, so that the steam is swept away as quickly as it is formed, water from the drum above filling its space. This rapid circulation largely prevents the deposit of incrustations upon the heating surfaces, the greater proportion of such sediment being swept away and deposited in the mud drum, from which it is blown out. The continuous circulation is not impeded in any way by a counter current, and the temperature throughout the boiler is maintained at an equal degree, so that all liability to unequal expansion of any particular tubes, especially those nearest the hottest gases from the furnace, is overcome, since a tube will not increase its temperature, and expand, so long as there is a constant supply



BOILER ROOM OF THE U. S. S. "CINCINNATI," EQUIPPED WITH BABCOCK-WILCOX BOILERS.

of water playing through it. The steam leaves the horizontal drum through a dry pipe connected with the stop valve on the top of the drum.

A very serious drawback in some water tube boilers is the presence of screwed joints. Such joints always give trouble, and lead to the loss of enormous quantities of water through leakage. The presence of these joints in the Belleville boiler constitutes one of its greatest weaknesses, which cannot be overcome, since it is an inherent defect. In all the latest types of water tube boilers care is exercised either to dispense with screwed joints altogether, or at any rate to reduce the number to the minimum. Even then, however, there is always a feeling of insecurity, owing to the liability of the joint to fail at some critical moment. There are no screwed joints in the tubes of the Babcock and Wilcox boiler. All are made with the ordinary expander, metal to metal, and no trouble is ever experienced by means of leakage.

The arrangement of tubes in this boiler is such that it insures high efficiency of combustion, because as the tubes are staggered the currents of gases produced by the combustion of the coal or other fuel are broken up as they pass in and out among the tubes, and made to give up to the tubes (and therefore to the water contained therein) a large proportion of their heat units.

There are other important advantages accruing from making the course of the gases approximately right-angular to the heating surface instead of gliding by the tubes, as is the case with fire tube boilers. As the currents of gases are deviated from the directly straight course by this staggered arrangement of the tubes, they come in contact with the whole of the outer surface of the tube, so that the maximum amount of heat is absorbed, and little heat is wasted, thus improving the economy of the boiler. From experiments that have been carried out in our own navy with this arrangement of the tubes it has been proved that this system absorbs thirty per cent more heat than is the case with the arrangement of the tubes practised in the ordinary locomotive boiler.

Another very important characteristic is its high capacity, which is one of the most important features of any boiler, be it either water or fire tube. There must be an ample supply of both steam and water to insure regularity of action; otherwise, the steam will fluctuate high and low with great suddenness, and thus militate against the success of the boiler. To obtain regularity in this respect it has been generally contended that plenty of space for the steam is essential, but this is a fallacy, as continued experiments in this connection have conclusively demonstrated. For instance, if there be too much space for the accommodation of the steam, time is lost in getting up to the desired pressure, and while this entails a great expense in the combustion of fuel in starting the boiler, it also signifies a greater radiating space than is necessary, and the loss of steam from this cause alone is considerably augmented. On the other hand, if the steam space is cramped, the steam in passing away from the boiler sweeps away with it a large quantity of water in the form of spray. To make the action ideal there should be just sufficient space for the steam to enable the boiler to be driven to the utmost, and yet always maintain a steady water level, and at the same time always permitting the steam to pass away perfectly dry.

The Babcock and Wilcox boiler is conveniently accessible at all vital parts for cleaning and renovation when necessary. The handholes at the front of the tubes upon the headers are easily detachable, to enable the tubes to be cleaned, and as the latter are perfectly straight, this operation can be completed very quickly. There are also manholes in the steam and water drum, and handholes in the mud drum for the same purpose. The interior of the boiler is also easily accessible through the manhole, and the employment of steam ejected from a blowing pipe attached to a rubber hose is convenient for the removal of any soot that may have gathered upon the top outer surface of the tubes. This latter possibility, however, is not a very general one, since if good fuel is burned there will be but little soot deposit. As, however, the quantity of dust or soot that can collect upon the top of a small tube is strictly limited, the boiler becomes in a great measure self-cleaning, so that recourse to the steam pipe is not often necessary.

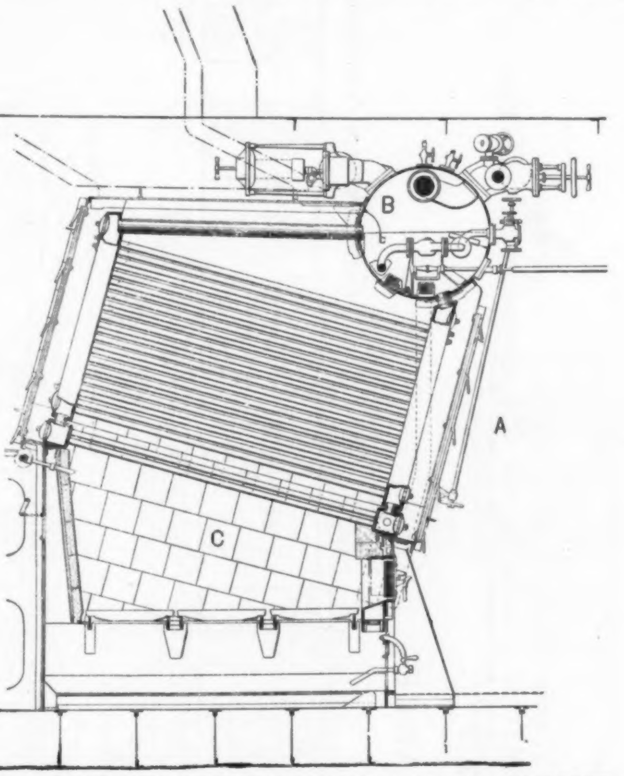


FIG. 1.—BABCOCK AND WILCOX BOILER SHOWING INCLINED ARRANGEMENT OF TUBES, FIRE-BOX AND WATER AND STEAM DRUM.

A, tubes; B, steam and water drum; C, fire-box.

From a cursory examination of this boiler it might be opined that owing to the rigidity of the whole structure, there existed great danger of unequal expansion in the tubes, and the fixed parts of the structure coming into contact with the furnace gases, thus sharing and weakening the vital parts of the boiler. As already pointed out, however, this danger is purely hypothetical. The boiler is free to expand in every direction, and there can be no unequal strains due to difference in temperature, because of the perfect circulation of the water.

One of the great drawbacks to which all boilers are subjected is the accumulation of scale when fed with impure water. Nearly all waters contain some percentage of foreign substances, which though possibly of slight consequence when small in quantity, become of serious importance when the amount is large. When the water is evaporated these matters in suspension or solution are deposited upon all parts of the boiler, but principally upon the heating surfaces in the form of scale. Besides imposing an enormous amount of wear and tear upon the boiler, an accumulation of scale lessens its efficiency to a very appreciable extent. It has been found that an incrustation ¼-inch in thickness increases the fuel consumption by as much as 15 per cent. Consequently the utilization of impure water entails constant cleaning of the tubes to insure satisfactory working and to maintain the economy of fuel consumption.

Various methods have been adopted to mitigate this difficulty by chemical means. The most common impurities in water are carbonate and sulphate of lime and magnesia, in addition to organic matter, and attempts have been made to eliminate them, but with little success. The organic matter is easily removed by filtering the water before use, but with the lime and magnesia in solution the problem is of quite another character. To prevent, or at any rate to reduce the scaling, an agency must be employed which will not prove deleterious to the metal. In the Krupp works at Essen, where the water contains a large quantity of gypsum, barium chloride and milk of lime are used with good effect. In the majority of instances where a scaling preventive is requisitioned, the incrustation is not eliminated, but is softened and thus its removal is facilitated. There are several woods which when introduced into the water prevent the formation of scale; but in all instances, although the scaling trouble is obviated, the very agencies, mostly acids, present in the wood which effect the change, exercise a corrosive chemical action upon the metal, so that the remedy is worse than the disease. Again, soap, although it will prevent incrustation, causes the boiler to foam and is objectionable from this reason. During late years refined petroleum has been extensively employed for this purpose, especially in connection with water impregnated with sulphate of lime, but there are very great dangers incurred by the utilization of this agent. The petroleum gas constitutes a grave danger, and should a light be brought into contact with it when opening the tubes, an explosion will result with direful results to the boiler.

THE FOREIGN QUARTER OF NEW YORK.

FEW people realize what a large foreign population there is in New York. The following extract from an article on New York city, from Pearson's, gives a comprehensive idea of the foreign quarters:

"As to the international character of the population of New York, it is one of the largest German cities in the world. The native Germans number 322,343; including people of German parentage, it is said to be the third largest German city. The Irish number 275,102; the Russians and Poles, from which the Jewish population of the Ghetto mainly is drawn, 188,000. There are about 100,000 people in New York who cannot speak English. Many of these belong to the large Italian population. Last year 136,455 Italian immigrants landed at the port of New York, the total immigration through this port for the year ending July 1 being 493,380, the largest on record. The foreign population of New York, with its churches, clubs, societies, and other institutions, give New York such a cosmopolitan character that you can worship in almost any language and swear in as many more and be understood."

Restoration of Brass Articles.—For the regeneration of brass articles, says the Metallin. Rundschau, they are first freed from adhering dirt by the use of hot soda lye, then, if they are bronzed, dipped in highly dilute solution of sulphuric acid and rinsed off in clean water. Next they are yellowed in a mixture of nitric acid 75 parts, sulphuric acid 100 parts, shining lampblack 2 parts and cooking salt 1 part, then rinsed off and polished, and, to prevent oxidation, coated with a colorless spirit varnish, a celluloid varnish being best for this purpose.

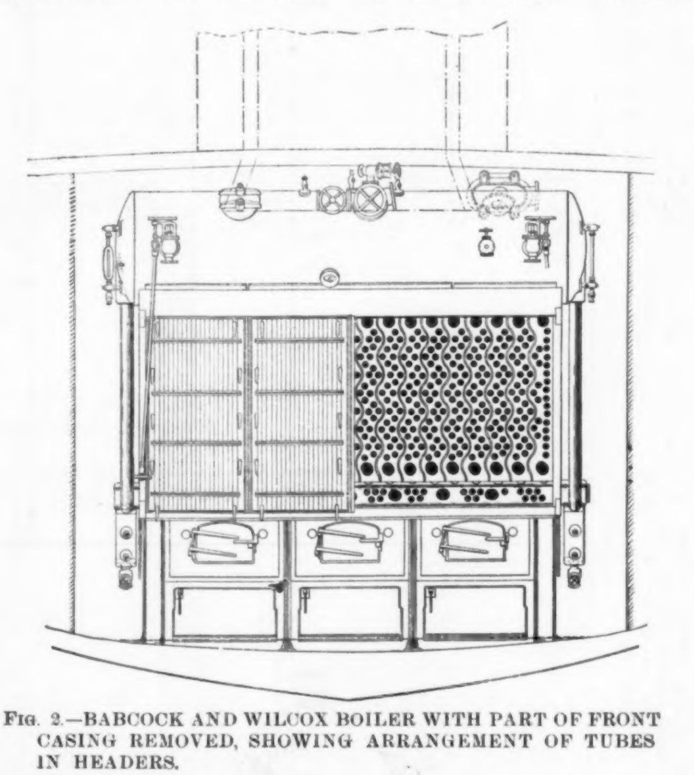
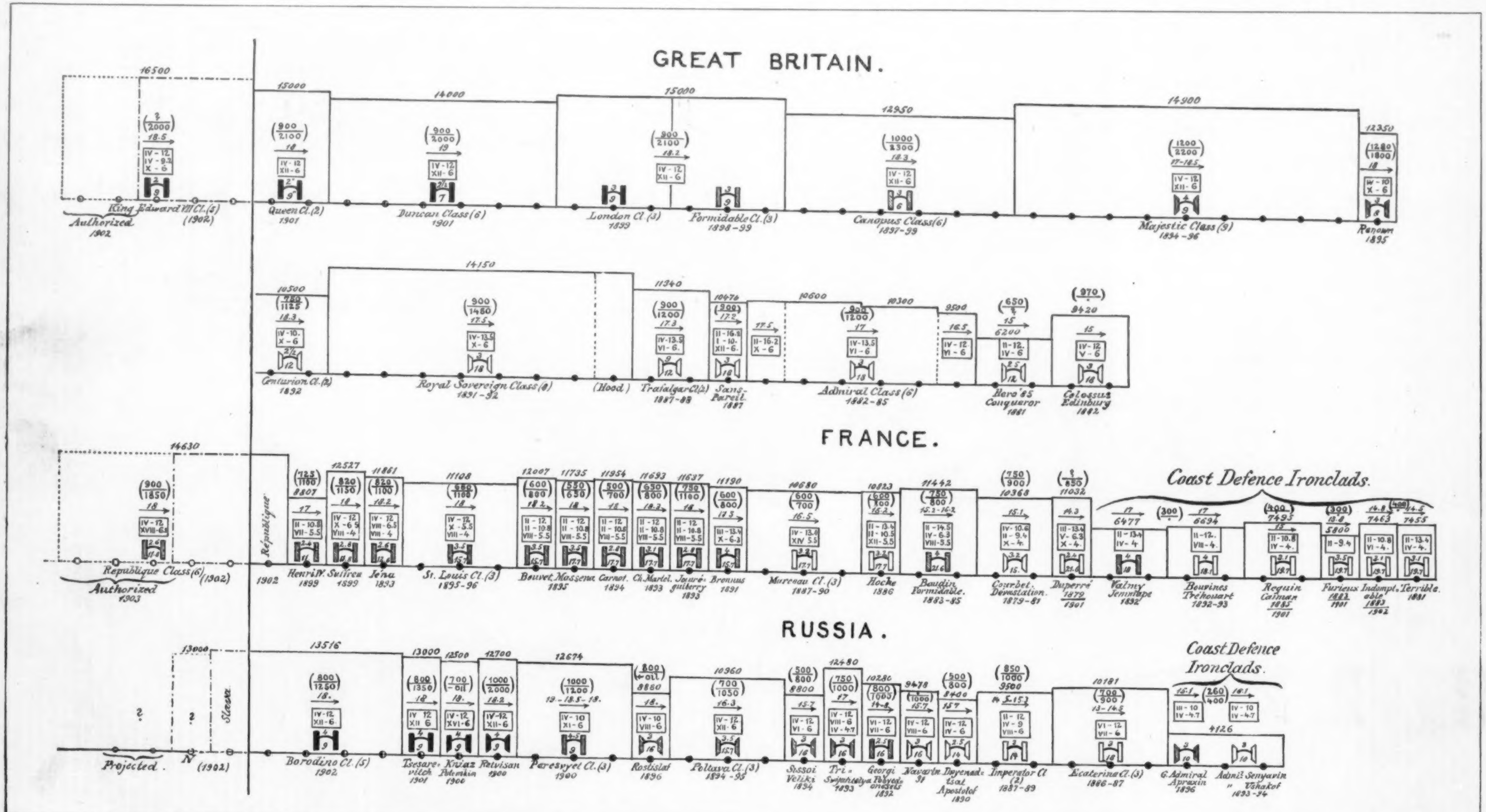


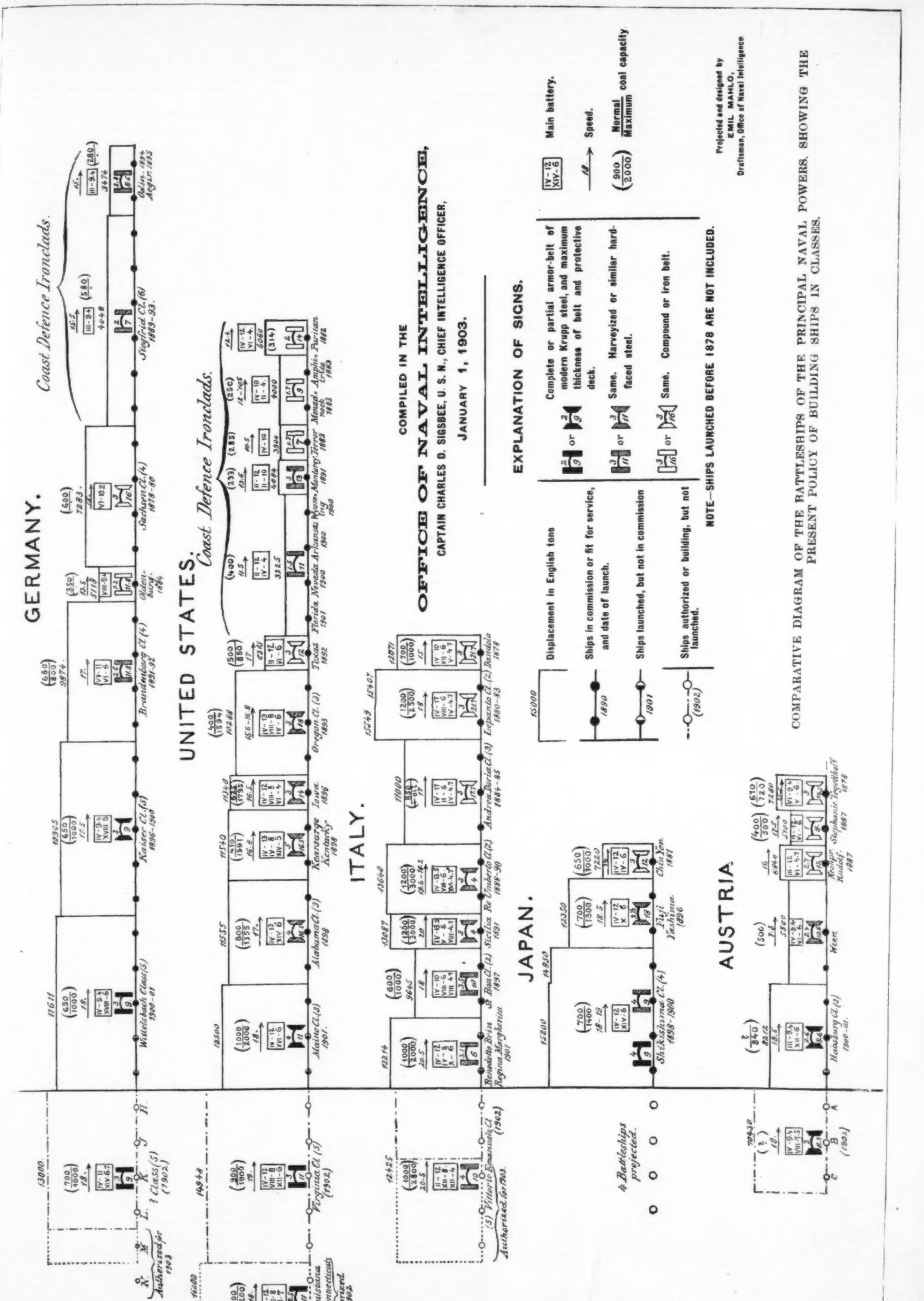
FIG. 2.—BABCOCK AND WILCOX BOILER WITH PART OF FRONT CASING REMOVED, SHOWING ARRANGEMENT OF TUBES IN HEADERS.

COMPARISON OF THE BATTLESHIPS OF THE WORLD.

The accompanying diagram, which has recently been prepared in the Bureau of Naval Intelligence, has been furnished to this journal by the courtesy of Capt. Charles D. Sigsbee, Chief of the Bureau. It was prepared for the purpose of giving a graphic representation of the comparative homogeneity of the different classes of battleships of the principal naval powers, the idea being to show at a glance that these navies have adopted a policy of building ships in classes, and while increasing the total number of vessels in their navies, keeping down, as far as possible, the number of different types. The value of homogeneity in a navy has always been clearly recognized by practical naval men, although unfortunately it has never been fully appreciated by the layman whose duty it is to vote upon the question of type of ships that are to be built for our navy. The great advantage of building a certain number of ships from a single design is realized when these vessels are engaged in naval maneuvers, or the stern business of war. If an admiral has under his command a fleet composed of heterogeneous vessels, varying in the power and method of placing their guns, in the weight and disposition of their armor, in their draft, or in their speed, he is at an enormous disadvantage as compared with an opposing admiral, whose vessels are built from one design or from designs that are very closely similar. Thus, with regard to speed, however fast his fastest ship may be, he will have to cut down the speed of his ships to that of the slowest ship, else the slower vessels will be left behind and the enemy will be given an opportunity to cut in, separate them from the main body, and destroy them at leisure. The homogeneous fleet, however, can steam at its full speed and always keep compactly to its battle formation. Then, again, vessels differ widely in the manner of carrying their batteries. Some are particularly suited for end-on fighting; others are weak in end-on fighting, and present their greatest concentration of fire on the broadside. Now, if the ships of a fleet in action are all of one type, the maneuvering of the fleet is greatly simplified, and the admiral can order such formations as will enable the fleet, as a whole, to concentrate to the best advantage its maximum amount of gun fire. The same is true of armor disposition; while it is impossible to place too great a value upon the question of coal supply. Taking the vessels shown on the accompanying diagram, it can readily be seen that if a fleet of battleships contained some vessels of the "Louisi-



COMPARATIVE DIAGRAM OF THE BATTLESHIPS OF THE PRINCIPAL NAVAL POWERS, SHOWING THE PRESENT POLICY OF BUILDING SHIPS IN CLASSES.



COMPARATIVE DIAGRAM OF THE BATTLESHIPS OF THE PRINCIPAL NAVAL POWERS, SHOWING THE PRESENT POLICY OF BUILDING SHIPS IN CLASSES.

ana" type, of our own navy, with a maximum coal capacity of 2,200 tons, and others of the German "Wittelsbach" type, which have less than one-half as much coal capacity, or only 1,000 tons, the "Wittelsbach" battleships would be the determining factor in the mind of the admiral when he was planning an extended cruise at sea. With a fleet made up entirely of "Lousianas" and "Connecticuts" he could keep the sea for many days longer without having to coal than he could if his fleet included some of the German "Wittelsbachs" or "Kaiser Wilhelms," with their very restricted coal supply. Another most important point in favor of building in classes, is that of maneuvering power as affected by the turning radius of the ships. Where half a dozen great battleships are to be swung suddenly to the right or left into new formations, the matter is immensely simplified if the circle in which they will swing with the helm hard over is the same for all of them. If they vary, as a heterogeneous lot of battleships will vary, greatly, the risk of collision in these evolutions is greatly increased. The maneuvers will be governed, of course, by the largest radius, just as the speed of the fleet is governed by the slowest ship; and the admiral as well as the captain of each ship must bear carefully in mind the maneuvering capacity, not only of his own, but of other vessels. If they do not, or if some error of memory or judgment occur, the result may be most disastrous, as witness the sinking of the "Victoria" by the "Camperdown" some years ago in the Mediterranean Sea. The accompanying diagram shows that the leading navies are giving practical recognition to these well-known principles, and of late years it will be seen that not less than three, and as many as five and six vessels, are ordered of each type. Great Britain set the example more than a decade ago, when she built the nine great battleships of the "Royal Sovereign" class, following these by nine "Majestics," six of the "Canopus" class, six of the "London"-"Formidable" class, six "Duncans," and now five of the "King Edward" class. France has not built in classes until she authorized six vessels of the "Republique" class. Russia has in hand her five vessels of the "Borodino" class and four of a later class. Germany has built her five "Kaiser Wilhelms," five "Wittelsbachs," and has in hand six of a later type. We have built three each of the "Alabama" and "Maine" classes, and have in hand five "Virginias" and two "Louisianas," with three more to follow this year.

The diagram itself needs but little explanation. All the ships lying to the right of the heavy vertical line have been launched; those to the left of it have not been launched, and are either under construction or authorized. The classes of ships are shown in squares, the height of which represents the relative displacements of the vessels, and the breadth the number of them. The full black circles on the base line indicate the ships in commission or fit for service, and the circles that are half black and half white indicate ships launched, but not in commission. The H-shaped figure in each square represents, by the curved horizontal line and the figure above it, the thickness of the protected deck, the figure below the curved line being the thickness of the vertical side armor. The battery is indicated in the little white square, the Roman figures indicating the number of guns and the Arabic figures the size of the guns. The speed is indicated by the figures above the horizontal arrow. The coal capacity is shown at the top of the squares, the upper figures representing the normal and the lower the maximum coal that can be carried. All of the vessels shown in this diagram have been launched since 1878.

JANE NAVAL WAR GAME.

OWING to the interruption to the playing of the Jane naval war game in England, occasioned by the recent holidays, our readers will miss the usual weekly account of the game in the present issue. In next week's issue will be described the laws according to which the game is played, and more particularly the method by which the naval officers simulate the shooting of an actual conflict, and make a record of the hits as the game proceeds.

CONSIDERATIONS ON THE CHOICE OF A PHYSICAL UNIT OF DECIMAL TIME.*

THE numerous papers published in the Bulletin de l'Association pour l'Avancement des Sciences, exhibit the importance of the problem of the application of the decimal system to the measure of time and of angles. These efforts have received great encouragement.

The question of the angle is definitely solved, for the principal departments have adopted the division of the quarter of the circle into one hundred equal parts, called grades, and decimal subdivisions.

This new angular unit will modify the physical and mechanical constants a little; but all the practical tables necessary for immediate employment of the grade are at hand.

The French Navy will without doubt soon follow this course resolutely. It will thereby secure a saving of time and a greater facility in calculations; its charts will be graduated like all the other French cartographic delineations.

The adoption of a new decimal physical unit of time is also necessary. There will be more difficulty than with the angle, for it will modify all the physical constants relating to time. This explains the repugnance, quite exaggerated in my opinion, which electricians manifest to any change in the notation of time. It will therefore be suitable to select a new physical unit of time, satisfying all requirements. The new unit ought not to deviate much from the present sexagesimal second, which is convenient in all respects. The hundred thousandth part of the mean solar day fills all the conditions completely. Its duration, amounting to 0.864 second, is sufficient to prevent embarrassment in counting the ticks of a clock beating that interval of time. The eye follows without fatigue the movements of such a pendulum. A man's arm beats the measure of the time without haste or delay. Finally, the healthy human adult pulse beats on the average 100,000 times a day.

MM. Biot and Mathieu determined experimentally at the commencement of this century the length of the pendulum beating 100,000 times a day. This interval of time is altogether suitable for the new decimal physical unit of time, which is what I propose, as did the immortal authors of the metric system.

M. Juppont of Toulouse has made another proposition: he thinks that for unifying and having a perfect accord between the time and the angle it will be well to divide the quarter of the day decimally. By taking its ten thousandth part, he obtains the value 2.16 seconds, which he calls a *bisecandé*, of which the cube is about 10. The coefficients 2.16, $-(2.16)^2$, $-(2.16)^3$ will cause in his opinion but little mod tion in the new electro-magnetic units. He therefo. proposes to adopt the bisecande as the new physical unit of the time.

This lapse of time is, I think, too long, and besides it decimalizes only the quarter of the day. Now, the day is a natural unit of nature, and a logical and rational decimalization cannot be sacrificed because the new electro-magnetic unit will differ a little from the old. It is needful to examine the desiderata of the different branches of science before making so radical a reform.

The hundred-thousandth part of the day, which I denominate a *millicé*, is already called for by a large number of scientists. It appears to suit nearly every one, for it is decimal and varies but little from the present second, its exact value being 0.864 second.

Such a reform will be readily introduced, because the operation will be methodical. It will be necessary in the first place to give the pupils of the lyceums, the colleges and the primary schools, information on the employment of the decimal system for the measure of time. It will be an excellent complement to instruction on the metric system of weights and measures. Every one will quickly comprehend the advantage of the new system and will be in favor of its adoption.

For scientific circles, it will be necessary, I think, to proceed more quickly. For this purpose I have calculated practical tables for the conversion of the present units into new units.

I have already demonstrated several times to the Association pour l'Avancement des Sciences that four principal coefficients will suffice for this conversion, namely: 0.864, $-(0.864)^2$ $-(0.864)^3$, and 0.648. I have already calculated and prepared multiplication tables from 1 to 99 of these essential factors.

In a pamphlet, entitled Principes de l'Emploi de la Division Décimale du Jour aux Unités Electro-Magnétiques, addressed to the members of the Société Française de Physique, I have already developed this subject. This is a summary, in a few words, of the principles of the reform. All the measures relate to the *millicé* (this is the name I give to the hundred-thousandth part of the day), to the centimeter, and to the gramme-mass. I designate the system by the three letters M. C. G. The new units are preceded with the prefix *no; novitesse, nodyne, nowatt*, etc. For the multiples I adopt the proposition of M. Blondel: *kilo, duo, trio*, etc., for 10^3, 10^6, 10^9 etc.; and *milli, billi, trilli*, etc., for 10^{-3}, 10^{-6}, 10^{-9}, etc. So that the expression *trionowatt* signifies 10^9 nowatt units of the system M. C. G. Thus, the confusion incidental to the present units is avoided. We can pass from one system to the other with very great facility, as one kilowatt is equal to $10 \times (0.864)^3$ trionowatt. A power of 715 kilowatts is converted with the multiplication table from (0.864) or 0.64 49 73 for 700 451, 48 08

—15	32,	89	36
715	484,	37	44

Therefore 715 kilowatts correspond to 4844 trionowatts about. The time spent in the conversion is nearly negligible.

In the system M. C. G. the three fundamental units are decimal. Exact account must therefore be taken of the new unit of time. This is the hundred thousandth part of the mean solar day. Its value is in decimal fractions of each of the units now employed: day, 0.00001; hour, 0.00024; minute, 0.0144; second, 0.864.

The new unit of time is a little longer than four-fifths of a second. It may therefore be computed by means of a chronograph beating fifths of a second. The following method is still more simple. The normal pulse of a healthy adult man beats seventy times a minute, which amounts to 1440×70, or 100,800 times a day. The pulse of a man beating 69 or 70 times a minute indicates therefore the duration of the *millicé*.

There is a third method of giving the time of the *millicé*. A heavy body is allowed to fall from a height of 366 millimeters; the interval between the instant when it commences to fall and the instant when it touches the ground is exactly one *millicé*.

A fourth method consists in making a simple pendulum 742 millimeters in length. The short oscillations have a duration of one *millicé*.

The following formulas allow of solving the problems relating to gravitation and to the length of pendulums at different points of the earth's surface. In designating by λ the latitude of the place, and by h the height above the level of the sea, the acceleration G in units M. C. G. is

$$732.0182 - 1.8683 \cos 2\lambda - 0.00\ 00\ 02\ h$$

and the length of the pendulum beating the *millicé*

$$74.1690 - 0.1893 \cos 2\lambda - 0.00\ 00\ 00\ 2\ h$$

The following is an application of these formulas to the principal cities of Europe, etc.:

Localities	Latitude, grades.	Value of G. cm.	Value of L. cm.
Equator	0.00	730.15	73.980
Latitude of 50 grades	50.00	732.02	74.169
Munich	53.30	732.22	74.190
Paris	54.26	732.27	74.194
Greenwich	57.20	732.44	74.211
Göttingen	57.26	732.44	74.212
Berlin	58.33	732.50	74.218
Dublin	59.28	732.55	74.223
Manchester	59.43	732.57	74.224
Belfast	60.67	732.63	74.232
Edinburgh	62.17	732.72	74.240
Aberdeen	63.30	732.79	74.247
The Pole	100.00	733.89	74.358

Watchmakers have already constructed numerous time pieces adjusted to the decimal division of the day. The Paris Horological School has the first decimal clock constructed by Berthoud at the commencement of the nineteenth century; its balance beats the *millicé*.

The Carnavalet Museum and the Conservatory of Arts and Trades have fine specimens of decimal instruments produced during the Revolution.

Quite a number of tropometers have been constructed for the use of the navy. These instruments beat 200,000 times a day; consequently twice for each *millicé*. I have had a decimal counter beating the *semi-millicé*, and a two-faced watch beating 500,000 times a day constructed by the Le Roy firm. The decimal face has a central seconds hand giving the fifth of the *millicé*. The other face gives the ordinary hours and minutes. I have also designed a face giving both systems. The making of simple decimal chronographs, or split-seconds, presents no difficulty.

In brief, the essential realization of the apparatus is already satisfactorily assured. This was an important point, as the possession of decimal instruments is indispensable to the reform.

The application of the decimal system to the measure of time should therefore be thus effected:

1. By instruction in educational institutions. This is already accomplished in the Paris Horological School.

2. By the manufacture of decimal apparatus in order to enable men desirous of progress to make direct observations in the decimal system of the time. Of course, constructors are not expected to produce instruments in quantity, but they should place on their cards the announcement that they are ready to furnish decimal instruments on order. This has not yet been done sufficiently, and requires an extra outlay of but five centimes.

3. By circulating in scientific circles the tables of which I have spoken, and a list of the principal constants. Here, for example, is a table of different velocities for a *millicé* or hundred-thousandth part of the day:

	Meters.
A man's step	0.85
A horse's pace	1.00
Man's gymnastic pace	1.75
Horse on the trot	3.00
Horse on the gallop	4.00
Sail vessel	7.00
Steamer (transatlantic)	8.50
Skater	10.00
Freight trains	10.00
Omnibus trains	16.00
Carrier pigeon	16.00
Horse at the races	21.50
Express trains	22.50
Swallow	40.00
Velocity of sound	280.00
Breech-loading musket	370.00
Cannon ball	390.00
Velocity of the earth's rotation at equator	390.00
Velocity of the earth around the sun (kilometers)	2,600
Velocity of light (kilometers)	260,000

By the displacement of a point, the space during different periods in current life is ascertained. Sound travels 280 meters in a *millicé*. Therefore in a *centicé*, or 10 *millicés*, equivalent to 8.64 seconds, it passes over a space of 2.8 kilometers.

A horse in racing goes at the rate of 21.5 meters a *millicé*. To pass over a distance of 2.150 meters, he will take about a *decicé*, equivalent to 1.5 m.

Nice is separated from the island Rousse in Corsica by 175 kilometers. A swallow flying at the rate of 40 meters a *millicé* passes over this distance in 175000/40, or about 4.4 *cés*, or about 1 h. 2 m.

The rate of a transatlantic steamer is 8.5 meters a *millicé*. It covers therefore 850 kilometers per day, and 8,500 kilometers in ten days. It would travel around the globe (40,000 kilometers) in about 47 days.

It is useless to multiply examples.

The numbers of the table divided by 2, 3, 4, etc., gives the value corresponding to the half, the third, the quarter, etc., of the day. These examples will show, I think, to the least clear-sighted, the advantages of a logical and rational system for the measure of the time.

A NEW PROCESS OF STAINING GLASS.

A NEW process of glass enameling has been invented by Mr. Holiday, the well-known English glass painter, the most important feature of which depends upon its adaptability to decoration, on a far larger scale than has ever yet been attempted in enamel work. The enamel is somewhat similar to "Limoges," raised and adapted to decorative work on a larger and more elaborate scale, and is the result of several years investigation and experiments. Mr. Holiday has decorated several subjects by this new process, among which may be mentioned a fine altar piece (center panel and two side panels) representing the Crucifixion for a church in Edinburgh, Scotland. The figures (about three-quarters life size) are executed with both power and dignity, while a fine sense of artistic balance pervades the design itself, and the lighting effects are superb. The peculiar characteristic of this process is its "molded" surface; and the possibilities conveyed by means of this slight modeling beneath its coating of brilliant enamel. The actual groundwork is plaster, while the modeling is overlaid with a thin coating of metal, the colors being of the same description as those commonly used in China painting, while the enamel consists of finely powdered glass, which being placed in a closely woven little wire receptacle, is applied by the operating artist gently tapping and moving it until the powder is evenly distributed over the entire surface to be "fired," water being occasionally blown through a spray in order to "fix" the particles of glass. Here and there portions of the metal may be seen glinting through the colors after firing. This, however, is no disadvantage; indeed, it only serves to give an additional glow and warmth to the piece as a whole. With the exception of the face and members of the body where the flesh tints are painted with all regard to detail, there is practically no "shading" in the usual acceptation of the term, although in places, such as for

* From the French of M. J. de Rey-Pailhade, in the Revue Internationale de l'Horlogerie.

instance draperies, it is deemed advisable at times to "deepen" the color used in the hollows; but the slight relief in which the figures and most important details composing the design is executed, lends itself naturally to a considerable play of light and shade, making all attempts at deliberate shading superfluous. The work therefore gains enormously in dignity by this grand simplicity and gorgeous "massing" of rich and luminous color.

HOW HAIR BRUSHES ARE MADE.

By J. R. McMINN.

ALMOST all druggists sell hair brushes, but few know much about their construction or the variety of materials that are employed in their manufacture. The value of a brush depends, of course, upon the quality and character of these materials. The construction of the brush is usually in accordance with the value of the materials, and in fact varies but little with the different qualities. Therefore a discrimination in regard to the materials of a brush is a safe criterion of its value, in most cases. It is the purpose of this paper to detail some information which may help the pharmacist to render his own judgment of the quality and value of the hair brushes which he may purchase, and to talk intelligently to his customers about their peculiarities and desirability.

The essential part is the brush or bristle portion. It is not always composed of bristles, but a good brush is always an all-bristle brush, nothing else.

The best variety is the Russian bristle, obtained from the back of the wild boar. It is a very stiff, tapering bristle, usually about 7 inches in length and is either white or black. They are the longest and stiffest bristle obtainable, and at the butt have the largest diameter.

The butt end only is employed for hair brushes; the opposite end, known as the flag, is much thinner and more flexible, and is used for paint brushes. The flag end branches near the top into six or seven fine points, which makes a very soft and thick brush. The butt end is about as large diametrically as a large needle, and the bristle tapers evenly. The bristles are usually collected from the peasants of Russia and Siberia by peddlers, and gradually reach points of shipment. In this market they are sold by weight, and usually bring about three dollars a pound.

The next grade of bristle is the Chinese, which is shipped from Tein Sein. It is a black bristle, about 5½ inches in length and is less firm and durable, but in other respects almost equals the Russian bristle. It now commands a price of about two dollars per pound, and is less used than formerly, when the price was lower.

French bristles command the next highest price, but are very fine in texture and are used almost entirely for paint brushes, not being stiff enough for hair brushes.

German bristles vary widely in appearance and price, ranging from a short bristle at about 50 cents per pound to the 6-inch bristle at about two dollars per pound. The color also varies, black, brown, and white being intermingled. The white bristles are sorted out and bring the best prices.

American bristles are short, being 2½ to 3½ inches in length, and are fine and flexible. They are better adapted to paint than to hair brushes, and are little used for the latter except to mix with the stiffer varieties. Being the cheapest bristle in the market, they are much used in this way. A peculiarity of the American bristle is that they are not straight as obtained in their natural condition, but are straightened by steaming.

Another variety of bristle, but rarely employed, is obtained from a variety of sea cow. The bristles are black, hard and very durable. But a peculiarity is that they are hollow and difficult to prepare for use, so that their value is lost.

It is evident from the above that only the largest and most expensive of bristles are suitable for hair brushes, the butt ends being used for these while the flag ends are employed for other kinds of brushes. The expense of the bristle is thus divided between the hair and the paint brush. The hair brush bristle must be stiff and resilient, while the paint bristle should be soft and flexible.

Bristle substitutes are employed in cheap brushes, and to some extent in adulterating the better grades. They are the fibers of certain plants or trees, dyed and stiffened to imitate bristles. There are three varieties in use, known as Tampico, Palmyra and Palmetto respectively.

Tampico is a fiber from the leaves and flower-stalks of the different varieties of the century plant, and is obtained from Tampico in Mexico. The leaves and stalks are gathered into heaps and allowed to rot until the softer portions can be beaten away from the hard fibers, which are then separated and dried. They are then bleached, colored and stiffened to imitate bristles, and shellacked or varnished to impart the required luster. Thus prepared it takes a close observer or a practised eye to distinguish them from true bristles. The fibers are hard and but slightly striated, and when finished resemble bristles closely.

The other two, the Palmyra from Africa and the Palmetto from South America, are the best fibers from trees, prepared in a similar way. The wood of the trees is very soft and the fibers are hard and tough. They are less successful as imitators of bristles than the Tampico, and are used only in the cheapest brushes.

These bristle substitutes are capable of making an attractive brush, but moisture and use soon take the stiffening out of the fibers, and the brush loses its resiliency.

Even in their prepared condition they are much less resilient than true bristles, and this affords a means of detection. Press your fingers or thumb into the center of a brush and then lift it quickly. True bristles will spring back to an upright position immediately, while the imitations straighten more slowly. Another method is to pull the bristle between the thumb-nail and forefinger, tightly pressed. If a bristle it will curl over; if a fiber it will droop or break off. A third test, less available but unmistakable, is to heat the sample until it smokes or burns. A bristle burns with the odor of burnt hair.

The backs have the next consideration. These are of wood, and many varieties are used. The main requirement is a wood that will stand close boring without splitting. The woods most commonly used are white wood, satin wood or box elder, and birch or ebony for the harder and heavier backs. The softer woods are frequently stained or dyed to imitate the hard woods. Dyes are made to penetrate the wood so that detection may be difficult.

The choice of woods is mainly a matter of taste, since the softer woods can be made to hold the bristles well. Ebony makes a heavy and handsome brush and is less easily broken but is costly.

Metallic and celluloid backs are frames fitted over the wooden holder of bristles, and have no advantages except, if preferred, in appearance.

Hard rubber and ivory backs are also a matter of individual taste or of price, there being no particular advantage in them so far as holding the bristles is concerned.

In the best brushes the bristles are "wired in." The bristles are bunched, bent over so that the ends are together and the loop end of the bunch is forced into the hole made to receive it. A wire passing through the loop, prevents the bristles being pulled out. In the split backs this is a comparatively simple operation, the brush being made on a thin section of wood bored full of holes in regular order. When the bristles have been fastened in, a thin cover of wood is glued over the side on which the wires rest and a suitable smoothing of edges and polishing or varnishing finishes the brush.

The solid-back, known also as the English-back brush, requires a harder and heavier wood. A piece is taken of the size and thickness of the desired back, and holes to receive the bristles are bored about two-thirds through the wood. Very fine holes are also bored lengthwise of the piece and midway of its thickness, so that the bristle holes each are connected by the finer holes at right angles. Through the small longitudinal holes a small wire is passed and fastened at one end. The workman then takes a small hook, draws the wire down through a bristle-hole, folds a bunch of bristles over it, and when the wire is drawn down through the next hole and pulled out the bristles are pulled into position and held there.

A resinous cement may be flowed into the holes as an additional precaution, but is not necessary when wiring is well done. Brushes so made show the filled ends of the longitudinal holes on the end of the back opposite the handle. Since bristle substitutes are not tough enough to stand this method of manufacture without breaking, a solid back and wired brush is usually indicative of a good quality of bristles. But there is a way of filling a solid back with imitation bristles of the cheapest character. In these the bristle-holes are bored in the same way, but the longitudinal wire-holes are omitted. The bristles are forced into the holes by special machines, and a special double pointed tack is driven in to hold them, which is afterward reinforced by cement.

There are thus in the market brushes having handsome hard-wood and solid backs, but containing only Tampico or Palmetto fibers in place of bristles. Such a brush becomes almost worthless in a short time.

The chief advantage of a solid back is that it is less liable to split or warp—because of heat and moisture. With proper care a split back is unlikely to give trouble in this way.

Some brushes of good quality are not wired, but have the bristles secured entirely by a cement. Many of the hard rubber backs are filled in this way, and are very serviceable. But with wooden or metallic backs, wired brushes are preferable.

A few directions to customers concerning the care of a brush may be in keeping.

A good bristle brush is not injured by frequent cleaning, but bristle substitutes soon lose their stiffness and fall out.

The wooden backs, however, of the best brushes may become softened by too much moisture, and the bristles then become loose. Avoid putting the brush into hot water, for the cement or glue may become softened if the bristles are not injured. A teaspoonful of borax and two or three teaspoonfuls of ammonia water in a quart of lukewarm water, makes the best washing-fluid for a brush. Rinse it well, and lay in the sun to dry and bleach.

With proper treatment a good bristle brush may be made to do good service for a life-time.—The Spatula.

RED LEAD AND LINSEED OIL.

A SPECIAL event has led me to consider, says Monsieur Vaillant in L'Architecture, the reasons which in former days led to the use of red lead, and lately of colcothar (improperly called minium of iron) for protecting iron from rusting. This protection of the metal from the effects of damp and acids has always been a subject of great interest for builders, but for all that I have found no trace of works showing any sign of that interest, and builders appear to me to have been content with the old traditions of the utility of red lead.

Our colleagues in the north of France think that it is unnecessary to paint iron which is shut up in masonry and sheltered from the weather, but others think that it cannot be regarded as being protected from damp even under those circumstances, and that it should therefore be always painted with red lead.

There is no process which gives complete security from the weather to iron work exposed in the open air. If they are oil painted, the painting has to be renewed and renewed until all details are smothered. Enamel scales off. Browning only acts as a very temporary preservative. Horn used hot with oil is still the best, but I have been unable to obtain any information about this singular process.

It is said that red lead and linseed oil form, in marked contrast to colcothar, asphalt, or coal tar, a composition which adheres very tightly to iron and has no action on it. The red-lead coat does not crack in drying or after drying. It does not blister or flake off. When the painting has to be renewed it is not necessary to remove the old color, and the other applications have to be scraped off, so that the new coat of asphalt, etc., can be put on a clean metallic surface.

The qualities essential for a protective coating for iron are impermeability, adherence and elasticity. It must respond without rupture to the expansion and contraction of the surface which it covers. The red-lead coating being a bad conductor of heat lessens these variations, so less call is made than would otherwise be the case on its elasticity.

Red lead is applied to ships' bottoms in the following manner: The iron is first made clean with hydrochloric acid and the vigorous use of rotary wire brushes. It is then rinsed with water and rubbed dry. It is then painted with the red lead and oil, which is first made into a thick viscid paste, which will keep several days without hardening. Just before use this paste is thinned with oil till it can be conveniently applied with the brush. Twenty-two gallons of color contain one hundred pounds of linseed oil and 400 pounds of red lead, and will cover 120 square yards for the first coat and 144 for the second.

The proper preparation of the surface to be protected is of the first importance, while the other essential is that the composition should be good. Now builders pay attention to neither of these points. They clean the iron perfunctorily, or, which is just as useful, they don't clean it at all, and they paint it with inferior qualities of red lead, often adulterated with ocher or even with brick dust. Such alteration will remain undissolved if the suspected pigment is boiled in a solution of sugar acidulated with nitric acid, which dissolves minium rapidly.

Iron forged at an engineer's and brought to a building is left about in all sorts of weathers, and, as above stated, is imperfectly cleaned or not cleaned at all, and then painted with inferior red lead. Besides, careless work leaves joints insufficiently protected by the paint, and as soon as rust gets hold in a joint the work is as good as ruined, as much iron work on outdoor carpentry testifies.

Although it must have been evident from the beginning of the use of iron its tendency to rust was its great drawback, no success seems to have been achieved in its protection until the revival of oil painting by Van Eyck, and the discovery that linseed oil had the power of drying in the air and covering surfaces with an impermeable coating. At a time when every painter prepared his own colors, and made all manner of experiments, it was quite natural that the increased drying power conferred on linseed oil should have been found out. No doubt the early attempts to prevent iron from rusting were confined to greasing it, and once the effect of lead on linseed oil had been observed it was not a great step to paint iron with red lead and oil. But so far as I know no systematic attempts have ever been made to establish clearly the conditions of painting iron with red lead and oil to compare its results with those of the anti-rust methods. Cloez did something toward it when he showed that the drying of oil was due to absorption of oxygen, and the influence of light, heat and extent of surface on that absorption. There is very little oxidation of an oil by the air in the dark, and less with colored light than with daylight, and less at low than at high temperatures. The special capacity of linseed oil in painting has thus been defined, but it is very doubtful whether that can be said of the bodies which are mixed with it, and which seem merely to give opacity and consistency.

It is unfortunate that the great difference in price among oils and the great difficulties in the way of recognizing them when mixed together are the cause of much adulteration. Chemists have long been trying to find out means of satisfactorily analyzing mixtures of oils, and it cannot yet be said that they have been entirely successful. The difficulty lies in the close similarity between the composition of different oils, and in the fact that tests which give a sharp reaction with a pure oil do not do so in mixtures containing it.

Hence the exaggerated demand for special siccatives. Some there are of these which can be of service when used with prudence and with reference to some particular object to be attained, but unless used in very small quantities they lessen the adhesion of the paint, and create a tendency in it to scale off, by making it less elastic and hence less conformable to the effects of changes of temperature upon the metal.

Insufficient cleaning of the surfaces to be painted, and the use of other applications than red lead and linseed oil are probably between them responsible for most of the failures experienced in iron painting. However that may be, there can be no doubt that red lead and linseed form a very suitable composition for protecting iron. Recent researches tend to show that an actual compound of linseed oil and a minium, a sort of lead-soap resembling india rubber, is formed. These researches also controvert a curious objection which has been made to painting iron with red lead. It has been said that the painted iron suffers by reason of a galvanic action being set up between the iron and the minium. It is singular that no one has ever advanced this objection to the painting of iron with white lead and linseed oil, an application which is exactly on all fours with the composition of red lead and linseed oil. The objectors to red lead and not to white lead also seem to have forgotten that the oil, especially when dry, is so bad a conductor the passage of any current seems absolutely impossible. At Bremen an iron coated with red lead eighteen years before was found to be absolutely insulated, so that it did not affect a galvanometer with tensions of 150 volts. In fact, the director of telegraphs at Hanover was led to suppose that even atmospheric tensions might be resisted by a mixture of red lead and linseed oil.

A paste of red lead and linseed oil is the only substance capable of closing hermetically joints subjected to great pressure from gases or water, and it is used in the manufacture of secondary batteries to protect metals from oxidation. The experiments of Hacketal have shown that a paste of linseed oil and red lead applied to vegetable fiber provides a solid insulating, weather-resisting envelope, capable of replacing gutta percha for overhead wires. The resistance of the dry mass is more than 640,000 megohms per square inch. The tissue impregnated with linseed oil pasted with from four to five times its weight of red lead loses

completely its hygroscopic properties and becomes an insulator equal to india rubber. It is insensible to all kinds of weather.

Two threads of bronze, each one-twentieth of an inch in diameter, were exposed to chlorine gas for a month, one naked, the other painted with red lead and linseed oil. The latter was not in the least affected, and the other was eaten completely through.

The present agitation against the use of lead in any form, from its poisonous effects on the workmen using it, is taking a wrong form. The right course is not to prohibit the use of lead and its compounds, which have valuable properties probably impossible to secure with any substitutes, but to find out and adopt methods whereby they may be used without injuring the health of those who have to handle them. Such must exist, and up to the present very little attempt has been made to find them.

AN ITALIAN RIVAL TO THE CHINESE WALL.

EVER since the time Italy imposed a duty on articles brought over her frontiers, the government officers have been given no end of trouble by smugglers. Finding it impossible to cope with the nimble enemies of her tariff laws, Italy now resorts to a scheme which may not be considered the most honorable method in the world of dealing with smugglers, but which is, nevertheless, conceded to be effective.

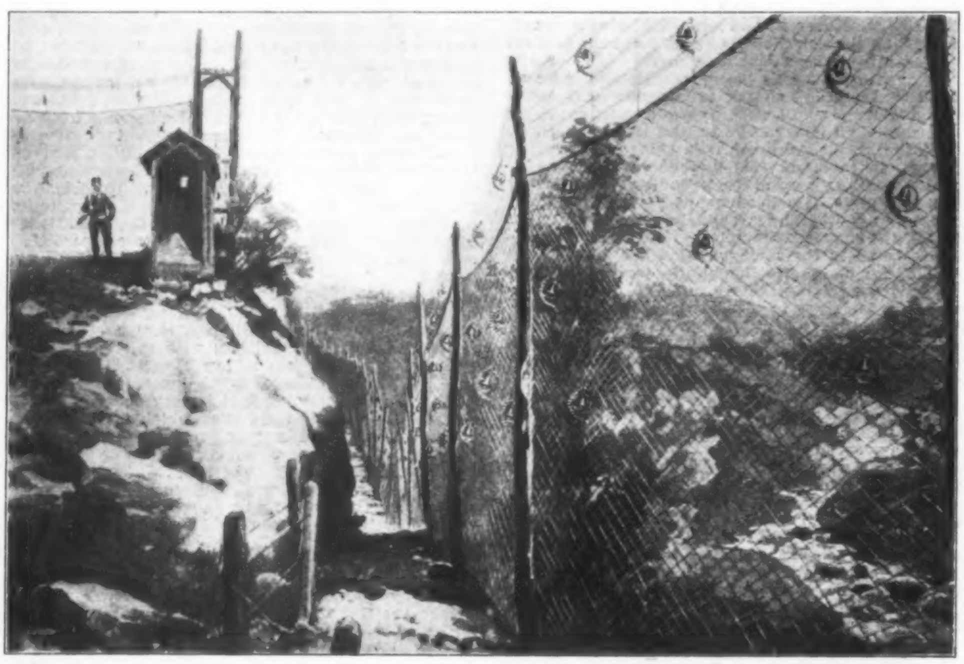
A wire fence has been erected along the Swiss frontier, which is provided with numerous small bells. The bells are hung on very delicate springs, so that the slightest attempt to tamper with the wires sounds a bell, which quickly calls the sentinel from his post. The smuggler who tries to pass this fence by cutting through the wires is sure to give the alarm. It is thus that Italy may be said to "bell her contraband cats."

THE FUTURE OF COAL MINING.

MR. T. J. DAVIES, president of the South Staffordshire and East Worcestershire Institute of Mining Engineers, in his presidential address at the late meeting, made the following remarks on the future of coal mining: There must be closer alliance between coal mining and industry. It is an interesting speculation whether we can double or treble the present output of coal within the present century, or may hope to reach an output of 1,000 million tons! Even that limit is not beyond the ingenuity of science. The question is whether the coal resources can stand it. There is geological evidence that the coal resources of the country are sufficient for the next 200 years if we are willing to mine to a depth of 3,000 to 4,000 feet. There is, therefore, not much cause for alarm. What is more important is the industrial problem of working deep mines. How are the geological and natural difficulties of deep mining to be surmounted? How is the natural heat of the mine to be subdued? It will be from 60 deg. to 80 deg. higher than at the surface, and there will also be the noxious gases to deal with. At present these difficulties make it impossible to work a mine 5,000 feet deep or more, but when the necessity arises who would say that mining science will have advanced so that the mine could be cooled down to the temperature necessary for the safety and health of the miners, and the other dangers removed. If those difficulties can be obviated the other difficulties of an engineering character could be surmounted. He ventured for a moment to pose as a seer of the future. The mine of the future would be, probably, from 5,000 to 10,000 feet below the surface; the workings could be reached by inclined drifts of 7, 8, or 10 miles in length. There would be two or three tunnels, and double lines in each would be set apart for traffic. Electric locomotives would travel up and down those tunnels drawing trains of wagons. In those extensive mines 7 000 or 8,000 men would be employed, and there would, in fact, be subterranean towns in which the workers would remain several days underground. The output would be 30,000 to 40,000 tons per day, and a large portion of the produce would be consumed in gaseous form or as electrical energy. No doubt that seemed like a mining romance, but he did not think it an extravagant assumption as to the capacity and triumph of engineering science when we have such a wonderful substruction of past experience and achievements on which to build up future success. The president terminated his address as follows: It becomes the duty of all business men to make preparations to meet the forthcoming formidable foreign competition by adopting all the aids of science and new methods. Our geologists must assist and direct the efforts to discover our hidden treasures of coal. Our mining engineers must solve the problem of economy and reduced cost of working deep mines. There is another duty—viz., that of the government to protect and encourage our coal export trade. He regarded the imposition last year of the tax on exported coal as a retrograde policy and detrimental to the coal-mining interest of the country.—Journal of the Society of Arts.

THE CHINA TEA TRADE.

THE change which has come over the tea trade, not of Foochow alone, but at other producing centers in China, and which is ruining what was once a flourishing industry, seems, according to H. M. consul at Foochow, ascribable to several causes, not all within the power of the sufferers to remedy. First, there is the indisputable fact that the use of due care in the manipulation of the leaf when growing, when being picked, and when being prepared for its transit over the sea, is not exercised by the native grower. The means of insuring all this have been repeatedly indicated to him, and put within his reach, with no result, owing either to apathy, ignorance, or dogged conservatism. He has been in turns implored, scolded, and lectured, but all to no purpose. Some years ago a circular was issued by the Inspector-General of the Customs, warning tea growers that owing to the superior methods prevailing in India, the trade was slipping out of China's hands—hands that used to supply the world. It was recognized by Europeans interested in the industry, that the lead taken by India and Ceylon has been secured by the substitution of machinery for hand labor. Machinery was accordingly imported. In some places, more even than this was done in the effort to infuse new life into a moribund industry. While Formosa was still Chinese the governor imported into the north of the island not only the machinery considered desirable, but even an expert from Assam. But neither in Formosa, nor in Foochow, have these devices proved of any avail. To the intelligent native they possibly appealed, but not to the fountain head—the grower and picker, whose methods continued to be unscientific and primitive. His livelihood was obviously slipping away from him, but the prospect of even that catastrophe has had no power to startle him from his invincible optimism. Secondly, there is the change which has come over the public taste in Europe. When China held the monopoly of tea production, China tea was necessarily bought. But when Assam and Ceylon entered into the competition, it was very soon apparent that the liking for their products was increasing rapidly, and China tea was in no long time hopelessly distanced. It is likely that as regards delicacy of flavor and aroma, the teas of China are still assured the suffrages of the cultivated few. Teas from the nearer East are, says Consul Playfair, admittedly coarser of taste, and contain a larger proportion of tannin, on which account they are condemned by medical men as prejudicial to digestion. But they make an attractive dark brew, and are economical in that a little of them goes a long way. Thirdly, the trade in Indian and Ceylon teas has been fostered by judicious advertising, to which the Foochow merchants have not resorted. Fourthly, the trade is crushed by an excessive export duty. When the duty on tea was first made specific, it no doubt represented fairly enough the 6 per cent *ad valorem* sanctioned by treaty. The diminishing value of teas has, however, resulted in the export duty representing 40 instead of 5 per cent. The first, second, and fourth causes seem beyond the control of the merchant, but the remedy for the third should be within his reach. Advertisement is the life blood of commerce at the present day, and is freely resorted to in all departments whenever there is an element of competition. Consul Playfair says that a dozen virtues might be predicated about teas without overstepping the bounds of truth. If the teas of India or Ceylon had occupied exactly the space once filled by the teas of China the case would be more desperate. But it is not so. If China teas disappear the breakfast tables of the world will be the poorer. As regards the Indian tea industry, in the year 1901 there were 524,797 acres of land under tea cultivation in India, producing 191,250,000 pounds of tea, giving employment to some 666,000 persons, and representing an invested capital of about £10,800,000. About one-tenth of the production was in Dhera Dun, the United Provinces, the Kangra Valley in the Punjab, and Travancore district in Southern India. The other nine-tenths are grown in the provinces of Bengal and Assam. The greatest activity was in the years 1897 and 1898, when 67,000 acres were added to the tea-growing area. This tremendous expansion in the output, without any corresponding increase in the demand, bore its inevitable fruit in the glut which has in recent years brought prices down below a fair profitable level, and consequently a healthy reduction of the rate of progress set in. Last year there were only 2,284 acres added, and in the ordinary course of events a decrease in succeeding returns may be expected. The United States consul in Bombay says that the price of tea in 1902, although higher than that of 1901, was lower than at any other time during the past thirty years. The ruling price at Calcutta during the public sale was about sevenpence a pound for broken Pekoe. The United Kingdom is still the greatest market for Indian teas, and India itself only consumes 5,500,000 pounds of home-grown tea, and 3,000,000 pounds of foreign, but the consumption in the country of the home-grown article is capable of considerable expansion.—Journal of the Society of Arts.



THE PREVENTION OF SMUGGLING ON THE ITALIAN-SWISS FRONTIER: NETS FITTED WITH BELLS.

CLAYS.

CLAY is essentially a silicate of alumina, but in nature we find clay and clays—they often vary a great deal in composition—on which acids, the actual tests for many matters, exert little, if any, influence. For crude tests, boiling with sulphuric acid is often sufficient; this will dissolve out the alumina, leaving the finely divided silica behind. Then those clays containing an admixture of calcium carbonate may be recognized by the effervescence following the use of the acid. All of the salts of alumina when moistened with nitrate of cobalt and heated before the blowpipe assume a characteristic blue color. Then when in solution alumina is distinguished without difficulty, the use of caustic potash and soda will throw down the white gelatinous precipitate of hydrated alumina which is freely soluble in excess of the alkali; while ammonia produces a similar precipitate insoluble in excess of this reagent and the alkaline carbonates as well as carbonate of ammonia will precipitate the same hydrate with the evolution of carbonic acid; and these precipitates are also insoluble in excess. The sulphide of ammonia, however, produces a white precipitate of alumina hydrate. It would be well for the clay user to familiarize himself with these tests. They are not difficult to manage, and the results are very reliable—so much that unless some extraordinary combination is presented no chemists can conduct a research more final or more reliable.

On filtering off this precipitate of alumina and adding ammonium oxalate to the filtrate a white precipitate will be obtained if lime is present.

As a result of the decomposition going on in the older rocks, or perhaps, to speak more correctly, in the minerals forming those rocks, by the action of the atmosphere clays are produced more or less pure, much sought after for certain manufacturing processes. China clay, a pure white substance, is closely allied in composition to the "kaolin" of China, whence the name kaolin comes. Viewed with the microscope, clays of this class are found to contain the crystalline pearly scales of kaolin, which is regarded as the parent clay, and is a hydrated silicate of aluminium, forming, as now known, the basis of the pure kaolin and all clays. The composition of this substance has long been a matter of dispute, but appears to agree with the recognized formula, $Al_2O_3 2SiO_2 2H_2O$.

Kaolin proper is almost invariably the result of decomposition of the granitic mineral felspar, and is therefore always found in association with felspathic rocks, usually granite. The European clay rocks, notably those of Cornwall and Devon, are simply granites in which the orthoclase felspar has become largely decomposed. The same results are apparent at Aue, in Saxony.

The formation of the kaolin from the felspar is supposed to have occurred in the following manner:

Water impregnated or charged with carbonic acid may act on the felspar so that it is partially decomposed, and its alkaline silicate removed as a soluble carbonate, while the real silicate of aluminium remains behind in a hydrated condition as kaolin.

When the decomposed felspar remains in the place where it is formed, then we have the deposits of china clay so largely mined in Cornwall, and used in the manufacture of pottery and in other trades. But when by rain, rivers, etc., it is removed and carried away to be subsequently deposited along with other bodies, we get the various other varieties of clay—brick clay, pipe clay, pottery clays, etc.—all of which have a basis of kaolin (perhaps modified by further decomposition), mingled with silica, oxide of iron, carbonate of lime, the extent and character of which determine the use to which the clays are put.

If the deposit of clay has been after deposition subjected to any influence which will cause it to become hard, then we get the various varieties of slates and shales.—Pottery Gazette.

THE BILLIARD MIRROR.

AT the Bairischer Hof, in Munich, last September, a large number of devotees of the billiard game assembled to view the latest invention pertaining to that noble pastime. This highly interesting novelty, a billiard table provided with six mirrors, which can be turned down, stood in the middle of the hall, and was studied and scrutinized with interest and astonishment by all the visitors.

The object of the invention is the following: By the use of one or more mirrors it is possible to see immediately in how many different ways a shot may be made, and even the tyro in the art of billiards, who can only make direct shots, is enabled by the aid of the picture in the mirror to execute the most difficult indirect shot as a direct one. It is strange that this interesting invention has not been made before, since it has long been known that the billiard ball leaves the cushion in the same angle in which it strikes it, and that a ray of light is likewise reflected in the same angle in which it falls on the mirror. As we are told, the Royal Bavarian college professor, Faller, conceived the general idea in working over a book on billiards, which contains this scientific theory, and which is to appear in about three months. Patents have been applied for on this invention in the various countries. The table with its accessories was constructed by a well-known firm of the city of Munich.

The billiard mirror is, as has been shown, the only possible and useful complement of the billiard table, since it affords a valuable aid even to the practised player in making difficult shots, and makes it possible for anybody, especially with the assistance of the aforementioned book, to learn the intricacies of the game, alone, in a short time. The test of the invention at the Bairischer Hof in Munich, at which the inventor gave instructive and entertaining explanations, was attended with complete success.

Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Illustrirte Welt.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

By MARCUS BENJAMIN, Ph. D.

THE fifty-second annual meeting of the American Association for the Advancement of Science, convened in Washington city December 29, 1902, to January 3, 1903, proved to be the largest scientific gathering ever held on this continent.

The opening session was held in St. Matthew's Church, when President Hall introduced the presiding officer of the session, Prof. Ira Remsen, president of the Johns Hopkins University. Addresses of welcome were presented by Commissioner Henry B. F. McFarland, representing the government of the District of Columbia, and on behalf of the national government by Dr. David J. Hill, Assistant Secretary of State. Other addresses of welcome were given by Dr. Charles D. Walcott, Director of the U. S. Geological Survey, and by Dr. Charles W. Needham, the president of Columbian University.

During the afternoon the retiring addresses of several of the vice-presidents were read, notable among which was one by Prof. William S. Franklin before the section of physics on "Popular Science."

The vice-presidential address before Section D was on the Modern Tendencies in the Utilization of Power, and was delivered by John Joseph Flather, who is Professor of Mechanical Engineering in the University of Minnesota. He said:

It has been stated that to the construction and perfection of her machinery, more than to any other cause, may be ascribed the present commercial supremacy of the United States.

Be that as it may, the economical production of her manufactures and the convenient adaptations of time and labor-saving devices in all the various lines of constructional work have certainly exerted a wonderful influence in the upbuilding of her industries.

Among other significant features the present tendency in the development and use of this class of machinery is marked by the adaptation of compressed air and the application of electric power to machine driving. In the use of compressed air, the facility of adaptation to various requirements which are in many cases additional to the supply of motive power, is a valuable feature peculiar to this system and one which is susceptible of extension along many lines.

The introduction of the electric motor in machine shops and factories was at first looked upon with disfavor and was opposed by many manufacturers, but the innovation obtained a foothold, and advantages which were at first unforeseen were found to attend its use, so that now it is being very generally adopted for a wide variety of work.

A considerable difference of opinion exists as to whether individual motors should be used with each machine, or whether a number of machines should be arranged in a group and driven from a short line shaft.

There are well defined conditions to which each system is best adapted, but there are wide limits between which there appears to be no general rule and we find both methods occupying the same field.

For isolated machines and for heavy machines that may be in occasional use the individual motor is particularly well adapted, as it consumes power only when in operation. It is, however, necessary that each motor thus connected shall be capable of supplying sufficient power to operate its machine under the heaviest as well as lightest loads.

As far as the efficiency of transmission is concerned, it is doubtful whether in a large number of cases motor driving *per se* is any more efficient than well-arranged engines and shafting.

As already pointed out, the principal thing to be kept in mind is a desired increase in efficiency of the shop plant in turning out product, with a reduction in the time and labor items, without especial reference to the fuel items involved in the power production.

One serious obstacle to the use of connected motors with machine tools is the difficulty of obtaining speed variation, which is so necessary with a large proportion of the machines in common use.

In many of the larger sizes of metal-cutting machine tools it is probable that marked changes will be produced in the immediate future, and the indications are that direct-connected motors with wide variations of speed and power will be incorporated in the new designs.

The recent improvements in the manufacture of certain grades of tool steel have shown indisputably that the present designs of machine tools are not sufficiently heavy to stand up to the work in order to obtain the economy of operation which results from the use of such steels. Higher speeds, heavier cuts and greater feeds may be obtained if the machines will stand the strain, but in most cases the capacity of the machine is not commensurate with the ability of the tool to remove metal.

With cutting speeds of 100 to 200 feet per minute, it is evident that the power requirements will be much greater than for the ordinary machines of to-day, which have a cutting speed of from 10 to 30 feet per minute.

As an illustration of what can be done with these new tool steels the speaker was recently shown some steel locomotive driving wheels which had been turned up in two hours and forty minutes, whereas the regular time formerly required was not less than eight hours. In this case even better results could have been obtained, but the belts would not carry the load.

Here then we find an interesting field for the direct-connected motor with ample power and speed variation for any work which it may be called upon to perform.

Reference has been made to the use of compressed air and its facility of adaptation to various requirements, but it is evident from an inspection of some of the devices in use that enthusiasm for new methods rather than good judgment has controlled in many of its applications.

For some years compressed air was used only in mines, where it produced marked economies in underground work. Later, compressed air was introduced into manufacturing lines, and to-day its use in railroad and other machine shops, boiler shops, foundries and bridge works is being widely extended. In the Santa Fe Railroad shops at Topeka there are over five miles of pipe in which compressed air is carried to the different machines and labor-saving appliances throughout the works.

New applications of compressed air are constantly being made, and each new use suggests another. This has a tendency to increase the number of appliances which are intended to be labor-saving devices, but in many cases the work could be done just as well and much more cheaply by hand.

A case in point is seen in an apparatus which was at one time in use on one of our prominent western roads. It was a sort of portable crane hoist which could be fastened to the smokestack of a locomotive, whereby one man could lift off the steam chest casing. The hoisting apparatus weighed about twice as much as the steam chest and took three men to put it up. When piece work was adopted, two men easily lifted off the steam chest, and this "time and labor-saving device" was relegated to the scrap heap.

The greater adaptability of compressed air to various purposes causes its use to increase along with that of the electric motor, for it has a different field of usefulness, independent of power transmission; at the same time, when the requirements are properly observed in its production and use, its economy as a motive power in special cases compares favorably with other systems. With a better knowledge of the principles involved we may expect much better results than have yet been attained.

There should be no comparison between the cost of power by compressed air and its brilliant rival, electricity, since each has its own field of usefulness, yet it may be interesting to note for our present purposes the efficiency of electric power.

When cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station; especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmission, which includes interest and depreciation on pole line, usually constitutes a large percentage of the operating cost.

In those localities where the cost of fuel is high, electric power can often be purchased more cheaply from a central station which possibly obtains its power many miles distant and transmits it electrically to a convenient distributing center where it is used for power and light.

The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the center of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal or long-distance transmission is not encouraging; while the development of the Texas and southern California oil fields has increased the visible supply and brought about increased activity in the use of liquid fuel, yet it is doubtful whether the advantages would be sufficient to cause it to come into general use as a fuel, since with a limited production and an increased demand for this and other purposes the cost would be correspondingly increased.

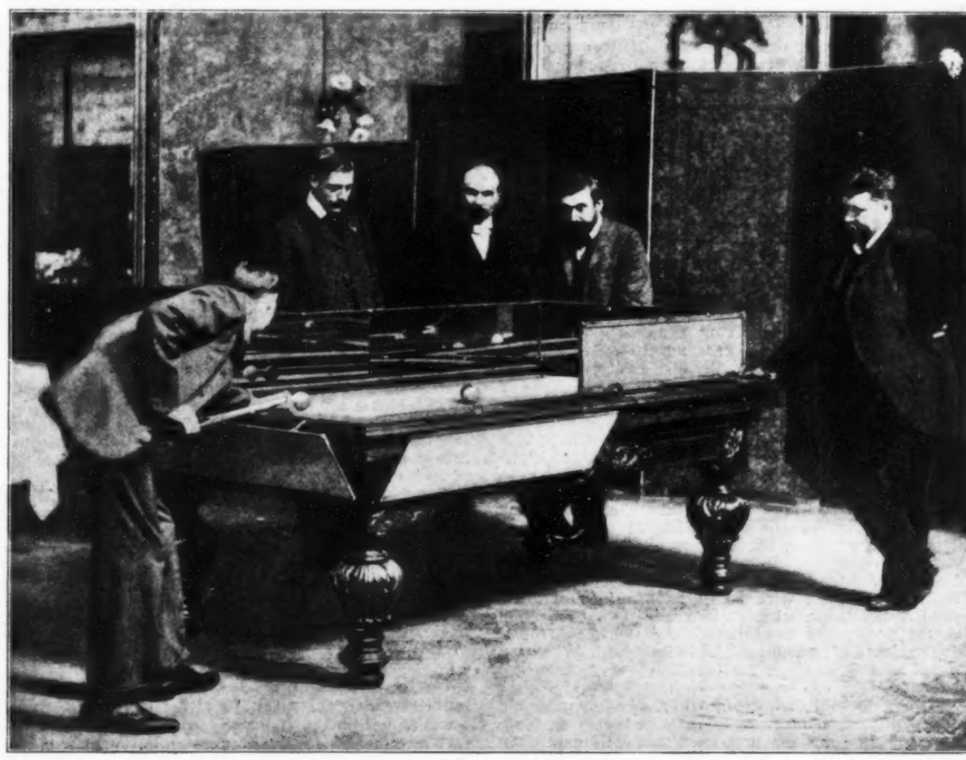
A number of railroads contiguous to the oil-producing centers have equipped their locomotives to burn this fuel, and it is used to some extent to fire marine boilers, and with great satisfaction, since its displacement for a given heating value is only about one-half that of coal, and the labor cost is materially reduced. It is also used quite extensively in certain sections of the country as a steam producer in power plants, but it is hardly probable that liquid fuel will be a serious competitor of coal, notwithstanding its many advantages.

At the present time, as far as power for manufacturing plants is concerned, it is largely a question of transportation, whether oil can be laid down and handled at a given point more cheaply than coal. It is probable, however, that oil fuel will supply a local demand in certain sections where transportation charges will permit its use at a low cost, and it is in this connection that it may become a competitor of electrical transmission.

One interesting phase of the power problem which forcibly presents itself to the engineer at the present time is the vast possibility possessed by the modern combustion engine, which includes the various types of gas and oil engines. While its use as a motor in industrial establishments has been somewhat limited, yet there is a marked tendency to employ the gas engine in manufacturing works, and a consideration of its advantages and cost of operation, together with its high thermal efficiency and possibility of still further improvement, indicate that for a great many purposes both steam engines and electric motors may be ultimately replaced by gas engines.

That the gas engine in both large and small sizes has reached a point in its development where it can fairly rival the steam engine in reliability and satisfactory running qualities there can be no question. In point of fuel economy, a gas engine of moderate size is on a parity with the largest triple expansion steam engines.

It is to producer gas that we must look for any



THE BILLIARD MIRROR.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

marked increase in the use of the gas engine. Fortunately, the manufacture of producer gas has reached a high state of development, and there are now in successful use several processes by which power gas can be made from cheap bituminous coals as well as anthracite and coke. The leanness of such gases renders them less effective per cubic foot of gas, as compared with the richer coal gas or even water gas; but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas engine as a general motor depends.

The gas engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilized direct in combustion engines without the intervention of boilers and without any special purifying processes. A still more important circumstance, which is far-reaching in its results, is the fact shown by Prof. Hubert of the Liege School of Mines that the superior economy of the gas engine enables equal power to be obtained with 20 per cent less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines in this way utilizes vast sources of power which a few years ago were allowed to go to waste or at most were used very inefficiently.

The practice of making the cylinder in combustion engines act alternately, first as air compressor, then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engine have been increased rather than decreased. Notwithstanding these well-recognized defects in the four-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas engines.

More recently very satisfactory results have been obtained in the construction of two-cycle engines. In some of these we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition, and this permits smaller clearance spaces with attendant advantages.

The highest thermal efficiency yet attained, namely, 38 per cent, has been secured with a two-cycle type of engine, but whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater complication of details in the two-cycle types as compared with the simpler four-cycle engines will cause the latter to continue to give the greater satisfaction, as least for the smaller sizes.

Although this country has lagged somewhat behind Europe in adopting large gas engines, there is evidence that this state of affairs will not exist very long, since a number of enterprising firms are already in the field prepared to build gas engines up to any required size. One firm has already sold over 40,000 horse power of large engines, most of them of 2,000 horse power and several of 1,000 horse power for coupling to electrical generators.

The use to which these large engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution.

While the gas engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use it direct as a motor.

A number of railroad and other machine shops have been equipped with small gas engines suitably located about the works, and in addition, thousands of horse power are used in the smaller sizes for a wide variety of purposes, including village water works, isolated lighting stations, and manufacturing plants of all kinds.

With the possibilities of high thermal efficiencies we may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas engine into very general succession to the electric motor for many purposes, for it will doubtless be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use will effect a material saving in the utilization of power over any existing methods.

It is not to be presumed that the gas engine will displace either the electric motor or the steam engine; each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas engine will be extended more and more into that of the steam engine and the electric motor.

Many of the questions involved in this consideration are at the present time in a transitional stage. The reciprocating steam engine has reached a high state of development, but it is not probable that it has attained its highest degree of perfection. While an economy less than 9½ pounds of steam per horse power has been obtained, even greater results may be anticipated; the use of high-pressure superheated steam in compound jacketed engines involves more perfect lubrication, and this may demand modification in existing valve types; however this may be, the outlook is promising for still higher efficiencies; whether this will mean cheaper power than can be obtained in other ways will depend upon many conditions.

In any case, and especially with intermittent or variable loads, it is not so much a question of maximum efficiency as it is economy of operation.

From this point of view the present activity in the construction and development of the steam turbine is of interest to engineers and power users. The steam consumption of a modern steam turbine of moderate size compares very favorably with that of the better class of large reciprocating engines, but what is of greater importance is the evident superior steam economy under variable loads. The steam consumption per horse power varies little from one-third to full load; at overloads the economy, as shown by numerous tests, may be even better.

This feature predestines the steam turbine to the special field of electric lighting and power generation, where it must inevitably become a formidable rival of the larger-sized slow-speed reciprocating steam engine.

It is a significant fact that immediately following upon the installation of the large 8,000 horse power compound steam engines at the central station of the Manhattan Elevated Railway, New York, we find three 5,000 horse power steam turbines under construction for the Rapid Transit Company, of New York.

The high rotative speed of the steam turbine is a prominent factor in favor of its adoption in connection with electrical generators, since the cost of the generator end of the equipment ought eventually to be very materially reduced; but for many lines of work the high rotative speed of the present types of steam turbine is prohibitive, nor can it be adapted successfully to belt driving. However, it is fair to presume that the present limitations of the steam turbine are not insuperable, and that the attention which is now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

The economies already obtained with both the steam turbine and the gas engine have brought each into a prominence which is at least suggestive of the important developments that are taking place in methods of obtaining and using power.

Prof. Charles C. Nutting, who fills the chair of Zoology in the Iowa State University, delivered his retiring address before Section F, on the subject of The Perplexities of a Systematist. He said in part:

It is well known among zoologists that there is a lack of harmony and co-operation between systematists and morphologists, the latter declaring that our schemes of classification are inadequate and clumsy—a former chairman of this section going so far as to prognosticate the supplanting of our present nomenclature by one which shall resemble more or less a logarithmic table.

The disagreement is largely the result of the instability of our generic and specific names, and by changes that often seem capricious and ill-judged.

Other causes add to the difficulty, and these were discussed in the address.

A frequent source of error is found in the haste with which systematists enter upon monographic, revisional or descriptive work without due training, and with an incomplete knowledge of what has already been done in their particular field. Nevertheless, since we must have systematists and no man is born with the requisite learning, we should strive to supplement the school of individual experience by additional instruction, that the public may be relieved of the crude work of unskilled hands and undisciplined brains.

A strong plea is entered for more systematic work in our colleges and universities, for that study of animals in relation to other forms which is now so generally neglected in favor of strictly morphological subjects. A graduated drill in descriptive work with study and discussion of classificatory problems gives a foundation upon which a student may base more ambitious labors, especially when he becomes a candidate for the higher scholastic degrees. After that he should be able to go into some of our great museums and enter on work of a lasting character.

The suggestion was made that some central library, such as the Library of Congress, take up the work of preparing bibliographies of species and issue cards to naturalists, something on the lines of the *Concilium Bibliographicum*, the whole to be under the supervision of some scientific body of high rank, thus relieving systematists of the most burdensome and profitless part of their work.

A conservative policy in the replacement of old classifications by new ones will lessen the criticism which has been directed against much of our recent work, and render the use of scientific papers easier without detracting from their real value. It will also tend to minimize the friction between systematists and morphologists and promote more cordial co-operation among workers in the various fields of biological science.

Section G, on Botany, listened to an address entitled "The Origin of Terrestrial Plants," by Douglas H. Campbell, who is Professor of Botany in the Leland Stanford Junior University, California. The following is a brief abstract of his remarks:

Some factors concerned with the evolution of plant forms are very obvious, others are not so evident, and the efficiency of some assumed factors is problematical.

The mutation theory of De Vries—sudden changes without apparent cause frequently occur, and are of great importance in determining the development of new forms.

Certain tendencies to vary in a definite direction are not easy to explain—e.g., the independent development of special sexual cells, heterospory, etc.

The external factors determining the course of evolution are three; relative to food; the water supply; need of reproduction.

There are no fundamental differences between plants and animals; lowest forms neither one nor the other. Lowest organisms usually motile; power of locomotion lost by most plants, except in the reproductive cells. Loss of motion is associated with power of photo-synthesis.

Development of specialized sexual reproduction has taken place in several widely separated groups of plants. There is much difference of opinion as to the significance of sexuality.

Photo-synthesis—the ability to manufacture organic compounds by utilizing the energy of the sun's rays—has been a very important cause for the development of many characteristic structures of plants. Leaves the most important photo-synthetic organs; leaves of lower plants analogous, but not homologous with those of the insular plants.

The relation to nature has been the most important factor in determining the character of the higher plants. All the lower plants are virtually aquatics absorbing water at all points instead of having special absorbent organs (roots) which characterize land plants. The change from the primitive aquatic life to land causes great changes in the plant body. Marine plants differ from those of fresh water in several respects. Some of very great size like giant kelps. Some minute plankton forms.

Fungi, a peculiar group of low plants of aberrant character. Fresh-water algæ develop special structure for resisting drought. Resting spores the commonest.

Growing period of fresh-water algæ restricted to periods of abundant water-supply.

Lowest land plants probably originated green algæ, which assumed an amphibious mode of life, vegetating in the mud after the water had subsided, very much as now occurs in Ricciocarpus.

The lower land plants, archegoniates, characterized by marked alternation of generations, sexual and asexual. Sexual stage, gametophytes, most important in lower forms, gradually superseded by asexual sporophyte. Two theories of alternation, antithetic and homologous; the former more probable. The sporophyte, at first strictly a spore-producing structure, gradually assumes the character of an independent plant with special organs, stem, leaf, root and sporangium.

Apogamy and apospory may be compared to adventitious budding.

Bryophytes, the lowest archegoniates, never succeeded in adapting the gametophyte perfectly to a terrestrial existence.

The sporophyte is essentially a terrestrial structure and has adapted itself to all phases of terrestrial life.

Presiding Officer of the Section on Anthropology, Stewart Culin, is Curator of the Free Museum of Science and Art of the University of Pennsylvania, in Philadelphia. The subject of his address was "New World Contributions to Old World Culture."

Mr. Culin has for many years made the subject of the origin of games a close study, and has become an accepted authority in that branch of anthropology. It was therefore natural in a vice-presidential address that he should turn to that topic and present some of his most recent views on the subject before the Section. He called attention to the fact that many of the games in the Old World were essentially identical with those that have been found in this country, and most interestingly described the details of many of these, leading to a conviction that the origin of many of these games was to be found in the arid southwestern section of the United States, which he claimed was the geographical center for the distribution of games.

An address that attracted considerable attention was the one delivered before Section I, entitled "The Psychology of the Labor Question," by the Hon. Carroll D. Wright, U. S. Labor Commissioner, and a prominent member of the Strike Commission appointed by President Roosevelt. The following brief abstract contains essential points of the address:

Observation and experience, covering many years of investigation of various elements of the labor question, have convinced me that there are underlying features which cannot be reached by the statistical method; that the mental attitude of parties has very much to do with the labor question from whatever standpoint it is considered. This is well illustrated by the statistics relative to mortgages. At the Eleventh Census an attempt was made to classify the causes or the reason for mortgaging homes and farms. It was shown that nearly 95 per cent of the mortgages indicated prosperity rather than the reverse. The motive of the mortgage indicated the psychological element. Considering this 95 per cent, it is found that the desire to add to the original holding, or to raise money for business operations either of the proprietor or of some member of his family, or to educate children, or for the improvement of existing property, was the motive. All these indicate something entirely different from the prevailing impression that a mortgage represents disaster, or failure, or some ill condition. The balance (5 per cent) represented the lack of business capacity, some form of failure, or disaster coming to the proprietor.

As a rule, statistics do not reveal the motive underlying the facts; hence the sociologist must study deeper than the statistical showings themselves. So, in the labor problem, one can ascertain the total number of strikes and the apparent causes, losses, etc., but the real motive of the strike cannot be disclosed by the statistics. Again, in studying causes, one must look to the apprehension which arises and really precedes action. The opportunity for injustice on the part of the employer leads many men to strike, although the injustice itself may not be a very great factor. These illustrations indicate the importance of studying the labor question from the psychological point of view, and of not leaving conclusions to be based simply upon the ascertained results of action.

The sections began their regular work on Tuesday morning, when they met, many of them holding joint sessions with the affiliated societies, and discussed the papers that had received the approval of the Sectional Committee. These affiliated organizations included the following named societies, many of which met for only part of the time: The American Anthropological Association, American Chemical Society, American Folk-lore Society, American Microscopical Society, American Morphological Society, American Philosophical Association, American Physical Society, American Physiological Society, American Psychological Association, American Society of Naturalists, Association of American Anatomists, Association of Economic Entomologists, Astronomical and Astrophysical Society of America, Botanical Society of America, Botanists of the Central and Western States, Geological Society of America, the National Geographical Society, Naturalists of the Central States, Society of American Bacteriologists, Society for Plant Morphology and Physiology, Society for the Promotion of Agricultural Science, Zoologists of the Central and Western States.

In a subsequent paper an effort will be made to mention some of the more important of the papers that were read.

The presidential address was delivered in St. Matthew's Church, one of the historic buildings of Wash-

ington. On the platform was perhaps the greatest number of past-presidents who have ever been gathered to listen to a retiring address of a president of the American Association. These included Simon Newcomb, the senior of them all; George F. Barker, Albert B. Prescott, Edward W. Morley, Theodore Gill, and Charles S. Minot.

Prof. Hall was introduced by President Remsen. In opening he said: "I take for the subject of my address the science of astronomy, and propose to give a brief historical sketch of it, to consider its future development, and to speak of the influence of the science on civilization. The science of astronomy is so closely connected with the affairs of life, and is brought into use so continuously and in such a systematic manner, that most people never think of the long labor that has been necessary to bring this science to its present condition." He then followed with a brief historical summary of the history of astronomy, from the earliest mention of it by writers, who showed its origin to have been prior to 150 B. C. The results indicate that more than two thousand years ago there existed recorded observations of astronomy. Hipparchus apears to have been one of those clear-headed men who deduce results from observations with good judgment. There was a time when those ancient Greek astronomers had conceived the heliocentric motions of the planets, but this true theory was set aside by the ingenious Ptolemy, who assumed the earth as the center of motion, and explained the apparent motions of the planets by epicycles so well that his theory became the one adopted in the schools of Europe during fourteen centuries. The Ptolemaic theory flattered the egotism of men by making the earth the center of motion, and it corresponded well with old legends and myths, so that it became interwoven with the literature, art and religion of those times. Concerning the latter he said: "The Copernican and Newtonian theories have stood the test of observation and criticism and they now form the adopted system of astronomy." Of the more recent developments in his favorite science, Prof. Hall discussed quite fully the laws of motion, passing then to the actual motions of comets and planets, the elements of their orbits, and similar topics. The problem of these bodies he discussed, tracing their historical development, and then took up the consideration of the recent progress in determining the positions of the stars. Photography, he said, will give great aid in determining the relative positions of the stars and in forming maps of the heavens. Future stellar astronomy has become a great and interesting field of research. The data for the motions of the stars are becoming better known, but these motions are slow, and the astronomer of to-day looks with envy on the astronomer of a thousand years hence, when time will have developed these motions. In closing, he said: A glance at history shows how useful astronomy has been in the life of the world. It has wonderfully enlarged the universe and widened the views of men. It shows how law and order pervade the world in which we live, and by the knowledge it has disseminated and by its predictions it has banished many superstitions and fears. The sciences will continue to grow, and they will exert the same influence.

The influence of the sciences in bringing men of different nationalities into harmony is great. This is done largely by the common languages that are formed in each science. In mathematics the language is so well formed and generally adopted that mathematicians all over the world have no trouble in understanding each other. It may be difficult to read Russian, but everyone can read the formulas of Tchebitchef and Lobaschewsky. In astronomy the common language is nearly as well established, so that there is little difficulty in understanding the astronomy of different nations. A similar process is going on in chemistry, botany and in the other sciences.

In our country we have one of the greatest theaters for national life that the world has ever seen. Stretching three thousand miles from ocean to ocean, and covering the rich valleys of the great rivers, we have a land of immense resources. Here is a vast field for scientific work of various kinds. No doubt the men of the future will be competent to solve the problems that will arise. Let us hope that our national character will be just and humane, and that we may depart from the old custom of robbing and devouring weak peoples. Any one who saw the confusion and waste in this city in 1862 might well have despaired of the republic; and he who saw the armies of Grant and Sherman pass through the city in 1865 felt that he need fear no foreign foe; neither French emperor, nor English nobleman, nor the sneers of Carlyle.

To destroy a democracy by external force the blows must be quick and hard, because its power of recuperation is great. The danger will come from internal forces produced by false political and social theories, since we offer such a great field for the action of charlatans. Our schools and colleges send forth every year many educated people, and it is sometimes disheartening to see how little influence these people have in public life. Those who are trained in the humanities and churches ought to be humane in dealing with other people, ready to meet great emergencies and powerful to control bad tendencies in national affairs. But this is rarely the case. On the other hand, the most unscrupulous apologists and persecutors have been educated men, and the heroes of humanity have come from the common people. This anomaly points to something wrong in the system of education, which should disappear. The increase and teaching of scientific ideas will be the best means of establishing simple and natural rules of life. Nature and science, her interpreter, teach us to be honest and true, and they lead us to the golden rule.

A Great Event at Antwerp among jewelers is the introduction of the new cut for brilliants, which has been patented in all countries where industrial property is in existence, by the firm of Jacques Kryn.

The best operatives must be employed, and of course the cost will be increased. It is said that the proposed increase of fifty per cent in wages will not be sufficient. It appears that the new cut originated with M. de Lara, formerly connected with the house of Ed. Van Dam, and at present with the Neresheimer firm at New York.

The new cut differs exceedingly in the division of the facets from the old brilliant.

The table is replaced with eight facets in the form of a rose. Then come eight stars, and then regular facets, in the style of the former brilliant.

Below are the same eight facets as in the table, but cut to the end. This result is obtained by the addition of a facet cut on the lines forming the corner and the pavilion below the old cut. Then a series of triangular facets are added on the sides.

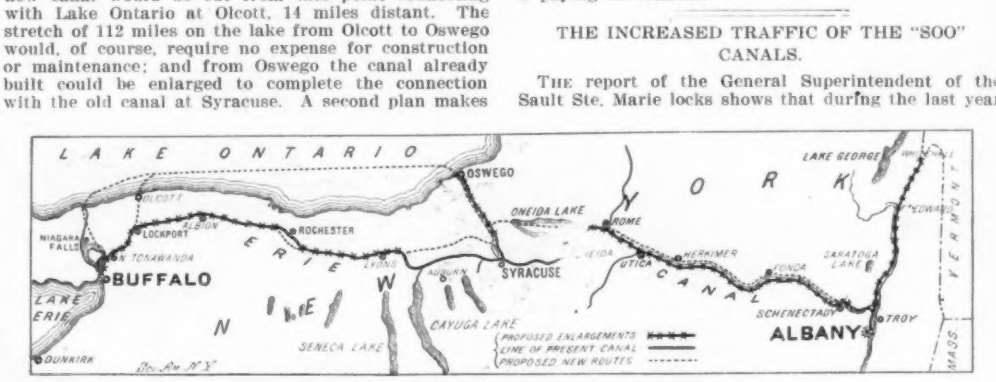
The fire and brilliancy of the new cut seem incredible. The effect, especially at night, is dazzling.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from the Antwerp correspondence of Le Diamant.

PROPOSED IMPROVEMENTS IN THE ERIE CANAL.*

GOVERNOR ODELL, in his recent annual message to the Legislature of New York State, reaffirms his belief in the necessity of a 1,000-ton barge canal between Lake Erie and the Hudson River. In presenting the exigencies of the situation the Governor points to the fact that under the present system, although the cost of canal transportation is but 0.19 of a cent per ton mile as against 0.59 of a cent for railroad transportation, traffic in the latter case is increasing at the expense of the former. Repeated failures during the past few years have attended every effort to check the rapidly-declining canal traffic, and the only remedy for these conditions lies in the immediate inauguration of extensive improvements. It will be interesting, in this connection, to review the several different plans for improvement on the present canal system which have been proposed. These differ mainly in two essentials, namely, the utilization of Lake Ontario for a portion of the waterway, as against building an inland course throughout. The accompanying map represents, by a heavy black line, the course of the old Erie Canal; the portions of the old canal which are to be widened and deepened to the required capacity are indicated by a series of dots on the black line; and the broken lines show the proposed new routes. One of the lake routes, which seems to meet with more general approval, follows the interior course from Buffalo to Lockport, and a new canal would be cut from this point connecting with Lake Ontario at Olcott, 14 miles distant. The stretch of 112 miles on the lake from Olcott to Oswego would, of course, require no expense for construction or maintenance; and from Oswego the canal already built could be enlarged to complete the connection with the old canal at Syracuse. A second plan makes use of 138 miles of open waterway. The Niagara River is utilized from Buffalo to a point just above the Falls, thence a canal is cut to Lewiston, from which point the Niagara River and Lake Ontario furnish the necessary waterway to Oswego. Both of these courses obviously eliminate the expense of enlarging the old canal from Lockport to Syracuse, and at first sight this seems to appear to be an important improvement over the inland course. However, it is open to a number of serious objections, which have influenced Gov. Odell to favor the latter route. These objections may be briefly stated as follows: The type of vessel required for lake navigation differs materially from that designed for canal and river use, and a vessel suitable to both conditions of travel would be expensive to build, would have to be more heavily constructed, and would therefore involve a loss in carrying capacity of at least twenty per cent. Aside from this, interest charges and cost of maintenance would be much greater. At present an ideal towing steamer on the canal, aside from towing a number of barges, will carry a cargo itself. Under the new conditions, probably a different type of towing vessel would be required on the lakes, which would involve extra expense in loading and unloading the steamers where the change from one type to the other was made. A still more serious objection to the lake routes is that of the weather conditions on Lake Ontario in early spring and late fall, which would cause frequent delays and involve the question of additional insurance. The lake route would also deprive a large part of the State between Lockport and Syracuse of the benefits of the improved canal, and it is doubtful if the counties thus passed over would be willing to pay taxes on improvements.

An interesting route, which, however, is not given much serious consideration, proposes utilizing the Niagara River as above, and then continuing the course along the entire length of Lake Ontario and down the St. Lawrence to a point from which a short canal could be cut through to Lake Champlain. This would be utilized to Whitehall at its southern extremity, and would connect there with the old canal, which would have to be enlarged as far as Fort Hudson, where it enters the Hudson River. This plan, while obviously a cheap route, is open to the same objections entered against the other lake routes, and emphasizes the serious objection raised against any opening into Lake Ontario; namely, that traffic would be more apt to utilize the outlet through the St. Lawrence, than to follow the slower and more difficult course down the Hudson.

The inland route, on the contrary, involves heavy expenditure, but should, nevertheless, prove a good investment. This course follows that of the present canal as far as Clyde, except for a slight deviation near Rochester. It is confidently asserted by the State engineers that this section of the old canal can be successfully enlarged to the required dimensions. From Clyde a new course is followed along the Seneca River to Baldwinsville, a short distance north of Syracuse; and thence following the Oneida River to Oneida Lake. The 15 miles of open water in Lake Oneida is utilized, and a short cut to New London will connect this route with the old canal. The course from New London to Herkimer involves the deepening and widening of the old canal, and from this point the Mohawk River would be canalized to its junction with the Hudson. It has also been proposed to rebuild the entire canal from Rome to Schenectady, and then make a short cut to the Hudson River in place of the old line to Cohoes; while another modification of this plan proposes the utilization of the Niagara River from Buffalo to Tonawanda. These two modifications would make use of 53 miles of canalized river, and 35 miles of open water, with 257 miles of earth section, and would require 45 locks. With the Mohawk River canalized from Hudson to Utica, the figures would change to 170 miles of earth section, 107 miles of canalized river, and 68 miles of open water, and the number of locks would be reduced to 38. This route, it is argued, would permit greater speed of transportation, since the channel would be open and unrestricted; furthermore, it would do away with a large number of railroad crossings and lift bridges, and obviate the problem of leading the canal across water courses, thus reducing the heavy expense of initial construction and subsequent maintenance. It is also argued in favor of this plan that from Troy to Rome, where the old canal follows along a side hill, it would be difficult to deepen the channel, while the Mohawk is in many places deeper than the required depth of twelve feet, and could be easily dredged to preserve a continuous channel of that depth. According to the estimates given by Gov. Odell, the cost of this enterprise will reach the sum of $225,000,000 for principal and interest. Notwithstanding this great expense, the interior route is urgently recommended, and gives promise of a paying investment.



PROPOSED IMPROVEMENTS IN THE ERIE CANAL.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE INCREASED TRAFFIC OF THE "SOO" CANALS.

THE report of the General Superintendent of the Sault Ste. Marie locks shows that during the last year the net tonnage of ships that passed through was 28,403,065, which represents the maximum traffic in the history of the canals. There is no other canal in the world through which so many ships pass. Last spring it was estimated that the traffic for the season of 1902 would net fully 35,000,000 tons. But the estimates fell short by at least 1,000,000 tons. The records up to December 1 show that through the canals there have passed 35,064,251 net tons. Probably a million more tons will pass through before the close of the season.

The greatest gain is shown in the shipment of iron ore. Last year 18,090,618 net tons of iron ore were sent through; this year the total reached is 23,966,724, or nearly 2,000,000 a month. In 1900 the ships reached a total of only 16,443,568 tons.

In the shipment of wheat a no less remarkable increase has been shown from 40,489,302 bushels in 1900 to 52,812,636 bushels in 1901, and 70,744,058 bushels to December 1 of this year. Flour has increased from 6,760,688 barrels in 1900, and from 7,634,350 to 8,459,085 barrels to December 1, 1902.

General merchandise has also shown an increase from 558,041 net tons in 1901 to 724,732 net tons to December 1 this year. All other lines have also shown a more or less marked increase, and Superintendent Ripley says that, in view of the building of larger vessels and the increase of mining properties in the Lake Superior region, the traffic for next year should be considerably over 40,000,000 tons, and may possibly reach as high as 50,000,000 tons.

The growth of Lake Superior commerce in the last fifty years has been phenomenal. The estimated amount and value of articles which crossed the portage in 1851 to and from Lake Superior was 12,000 tons, valued at $1,675,000.

In 1861 the traffic through the State locks was 88,000 tons, worth $6,000,000.

In 1871, 585,000 tons, valued at $13,000,000.

In 1881, through the State and Weitzel locks, 1,567,741 tons, worth $30,000,000.

In 1891, through Weitzel lock, 8,888,759 tons, worth $128,178,208.

In 1901, through the Poe, Weitzel and Canadian locks, 28,403,065 tons, valued at $289,906,865.

In 1902, to December 1, with no sign yet of a close of navigation, 35,064,251 tons.

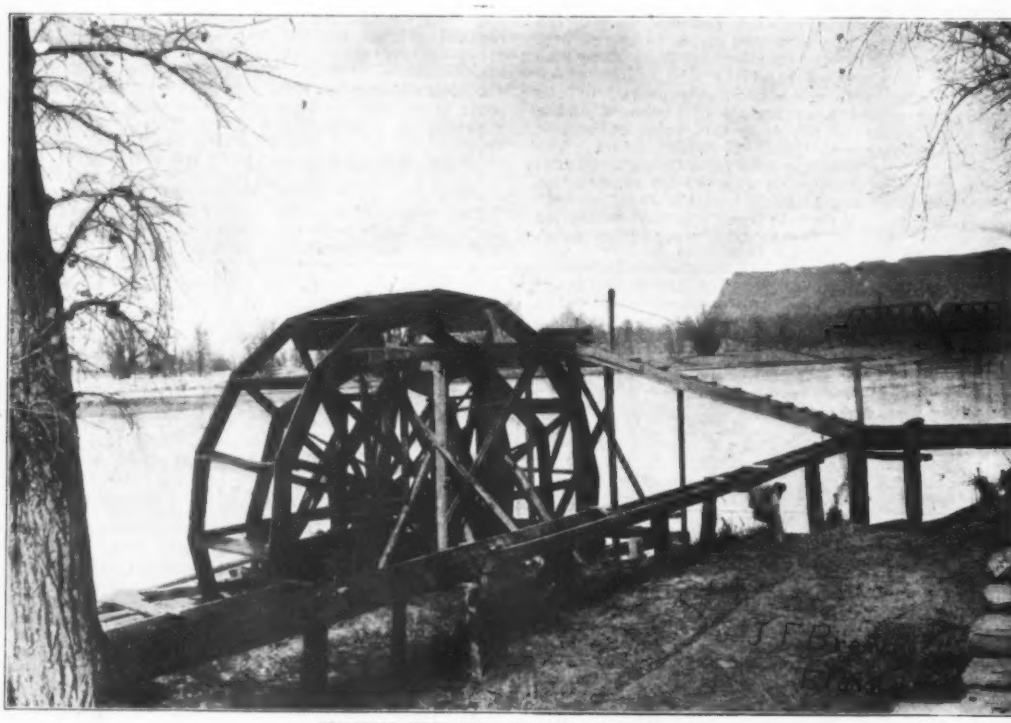
This enormous increase of freight and the constant building of larger and heavier draught vessels are the reasons for the agitation for a new and larger lock. When the Poe lock was built, with its 800 feet length and capable of locking through vessels drawing

twenty feet of water, it was thought that lake traffic would never grow any larger, and that vessels had reached a maximum, but the recent ordering of a 550-foot boat, with even larger ones contemplated, has made it apparent that the present locks will be unable to handle the traffic which will soon be passing through them. This is especially manifest in view of the fact that so many boats have grounded on the miter sill of the Poe lock this summer. It was supposed that the Poe lock would easily handle boats drawing twenty feet of water, but several have grounded drawing not over eighteen feet, and the Weitzel lock will not take a boat drawing more than fourteen feet. As it is now planned, the proposed new lock will be 1,300 feet long, and will lie outside the Poe lock. It will be constructed of concrete, which is cheaper and more durable than the stone of which the other locks are built.

[Continued from SUPPLEMENT No. 1410, page 22599.]

IRRIGATION.*

Watering by Furrows.—Irrigation in checks has gradually been given up, owing to the expense of leveling and leveeing the ground. With experience the irrigator has become able to apply water to crops which are cultivated in furrows, as, for example, corn and potatoes, without resorting to such expensive means. The furrows are plowed in such a direction that the water when turned into them from the lateral ditches will flow freely down them without washing away the soil.



WATER WHEEL AT ELGIN, UTAH.

When the water has completely filled the furrows and has reached the lowest points, the little streams are cut off and turned into another set of furrows. The methods of doing this differ in various parts of the country. Sometimes the irrigator simply cuts the bank of the distributing ditch with a shovel, and then closes the opening after sufficient water has escaped. A more systematic method commonly employed in California is as follows: Water is carried to the furrows in a small box flume with openings in the side. These openings are closed by little shutters and a number can be opened at once, permitting a certain quantity of water to escape into each furrow.

The slope given the furrows determines to a certain extent the amount of water received by the soil. If the fall is very gentle, the water moves slowly and a large portion is absorbed while the furrow is being filled. If steep, the water quickly passes to a lower end and the ground does not absorb so much.

When the entire field has been watered and the surface has become sufficiently dry for cultivation, the furrows are usually plowed out and a thin layer of the top soil stirred to make an open, porous covering or mulch, preventing excessive evaporation and allowing the air to enter the ground. Without such cultivation a hard crust may be formed, which, although retarding circulation, permits continual evaporation. The loosening of this crust breaks the capillary connection with the moisture beneath and thus lessens the loss of water.

For irrigating small grain, such as wheat, the ordinary plow furrows are not used, excepting in the construction of the distributing laterals. The fields, brought to a uniform surface, are thoroughly cultivated, and after the grain has been sown, small parallel lines are made similar to furrows, but smaller and nearer together. These tiny channels are made either by a peculiar drag or by a roller upon which are projections so arranged as to make small grooves in the soil. These are made in the direction of the desired slope, so that the water can flow down the marks through the grain as it would in furrows through a cornfield. The rapidly growing grain shades the surface and prevents the formation of crust, rendering subsequent cultivation unnecessary.

In order to cause the water to spread from the lateral ditches into the furrows through the ground, the tappoon has been applied. This consists usually of a small sheet of metal of such shape as to fit across the ditch. This can be forced into the soft earth, making a small dam and causing the water to back up and overflow the field of grain. Sometimes a canvas dam is used. This consists of a piece of stout cloth, one edge of which is tacked to a stick long enough to extend across the lateral ditch or furrow. The canvas falling into the furrow fits the sides and bottom, and is held in place by throwing a clod of dirt upon it. Water meeting the obstruction still further forces the canvas down, making a fairly tight dam, against which it accumulates and overflows into the field. After sufficient water has been turned out the canvas dam is pulled up and carried farther down the ditch, again placed in it, and another section of the field is irrigated.

Furrow irrigation is usually employed in watering trees and vines. In some localities, however, basin or pool irrigation is practised. It is frequently the case that where the best orchards and vineyards are situated water is procured with the greatest difficulty and its value is such that large expenditures are incurred in guarding it carefully from loss. The supply is conducted often in cement-lined ditches and by wooden flumes as near as possible to the trees and vines, and is then turned out into the furrows plowed around or near the trees. The water issuing from small apertures in the side of the wooden box falls into the furrows and is immediately conducted to the vicinity of the trees.

Care is usually taken that the water shall not actually touch the tree trunks, and it is extended far enough to wet the ground about the extremities of the roots to encourage these to spread outward as far as possible. After the water has traversed the furrows to the lower end of the orchard the supply is cut off and the ground is tilled as soon as the surface dries sufficiently.

Subirrigation.—Attempts have been made to conduct the water beneath the surface immediately to the roots of the trees, thus preventing waste by evaporation from the surface of the ground. Few devices have been successful, owing to the fact that the roots of the trees rapidly seek and enter the openings from which the water issues, or, surrounding the pipe by a dense network, cut off the supply. Porous clay tiling has been laid through orchards, and also iron pipes perforated so as to furnish a supply of water along their length. A machine has been invented and successfully used for making cement pipe in place. Small trenches are dug through the orchard between the trees and the pipe-making machine deposits the material in the trenches, which are filled with earth as soon as the cement is set. Water is thus distributed underground where needed.

In a number of orchards where subsurface irrigation has been unsuccessful because of roots stopping up minute openings beneath the surface, the system has been reconstructed and water has been brought to the surface at or near each tree by means of small hydrants. Vertical pipes are placed at short intervals leading to the level of the ground, and in these are small iron gates or shutters so arranged that the flow can be cut off in the buried pipe. Pushing down one of these gates the water rises and overflows the surface until a sufficient amount has been obtained. This gate is then raised and the next pushed down, and so on, until water has been caused to overflow at each point in succession down the slope of the ground.

For annual or root crops subirrigation has been successfully practised by the use of small iron pipes partly open at the bottom, allowing a small amount of water to escape. These pipes are laid at 12 inches or more beneath the surface, and are connected with lines of tile or clay pipes leading from the reservoir or source of supply. As the crops are removed each year, and the ground cultivated, the roots have no opportunity to stop up the pipes.

The term subirrigation is occasionally applied to conditions occurring in nature where water percolates freely beneath the ground for a considerable distance sufficiently near the surface to supply the need of crops. The ground is not actually saturated, but moisture is transmitted in sufficient quantity to nourish plants without drowning or water-logging the soil. These subirrigated areas, so called, are often located in broad valleys along a stream from which the water finds its way outward beneath the surface. They are occasionally found also upon gentle slopes where the moisture tends to form springs near the edge of the valley.

Where the subsoil transmits water freely, irrigation ditches may subirrigate large tracts of country without rendering them marshy. Thus farms may obtain an ample supply of water from ditches a half mile or more away without the necessity of distributing small streams over the surface. In the San Joaquin Valley of California, vineyards in certain localities are thus maintained in good condition, although water has not been visibly applied for many years. The closing of the ditches would, however, result in drying up the ground, and this obliges the farmers who are benefited by subirrigation to pay their share of the cost of maintaining the ditches, although they do not receive water directly.

It occasionally happens that the lower part of a subirrigated field must be drained to remove the excess of water. This can be done either by gravity ditches or by pumping devices.

AMOUNT OF WATER APPLIED.

The quantity of water required for raising crops varies according to the character of the soil. The plants themselves need a certain minimum supply, but a far larger quantity is required to saturate the surrounding soil to such a degree that the vitalizing processes can continue. The soil is constantly losing water by evaporation and by seepage, so that the amount which the plant takes from it is relatively small. Among the most important investigations on this subject are those by Prof. F. H. King, of Madison, Wis., who has found by direct measurement that from 300 to 500 pounds of water are required for each pound of dry matter produced. In other words, for each ton of hay raised upon an acre, from 300 to 500 tons of water must be furnished either by rainfall or by artificial means.

Water, covering an acre of land to the depth of 1 inch, weighs about 113 tons, and to produce 1 ton of hay the depth of water required is approximately from 3 to 5 inches. It is necessary to furnish at least this amount, and sometimes several times as much, in order to produce a crop. The actual amount required to produce 5 tons of barley hay is about 20 inches in depth.

When the ground is first irrigated an enormous quantity of water is sometimes required to saturate the subsoil. The quantity of water turned upon the surface during the first year or two has frequently been sufficient to cover the ground to a depth of 10 to 20 feet, and in some cases an amount equal to a depth of 5 feet or more per annum has been thus employed for several years. Gradually, however, the dry soil is filled and the water table is raised nearer the surface.

The pioneers in irrigation sometimes use excessive quantities of water, often to their disadvantage. They are actuated in part by the consideration that, having paid for the water, they are entitled to a certain quantity, and if they do not take it their claim to a perpetual right may be disputed. Equity demands that flowing water shall be considered as a common stock or fund, the right to the use of which shall be regulated, and beneficial use shall be the measure and the limit of such right.

The quantity of water used in irrigation is usually stated in one of two ways. First, in terms of depth of water on the surface, and, second, in quantities of flowing water through the irrigating season. The former method is preferable, since it is susceptible of more definite examination and is also more convenient for comparison with figures for rainfall which are given in inches of depth. In the humid regions the rainfall is usually from 3 to 4 inches per month during the crop season. In the arid region, where the sunlight is more continuous, and the evaporation greater, there should be for the ordinary crops at least enough water during the growing season to cover the ground from 4 to 6 inches in depth each month. Carefully tilled orchards have been maintained on far less.

The second method of stating the quantities necessary for irrigation is of convenience when considering a stream upon which there is no storage. It is estimated that 1 cubic foot per second, or 1 second-foot, flowing through an irrigating season of ninety days, will irrigate 100 acres. One second-foot will cover an acre nearly 2 feet deep during twenty-four hours, and in ninety days it will cover 180 acres 1 foot deep, or 100 acres to a depth of 1.8 feet, or 21.6 inches. This is equivalent to a depth of water of a little over 7 inches per month, during the season of ninety days.

It is instructive, in this connection, to know what is the least amount of water which has been used with success. To learn this, it is necessary to refer to southern California. Successive years of deficient rainfall in that State from 1897 to 1900 served to prove that with careful cultivation, crops, orchards, and vineyards can be maintained by using very small quantities of water. In some cases an amount not exceeding 6 inches in depth was applied during the year, this being conducted directly to the plants, and the ground kept carefully tilled and free from weeds.

As estimated by various water companies in southern California, 1 miner's inch of water will irrigate from 5 to 10 acres. The miner's inch in this connection is defined as a quantity equaling 12,960 gallons in 24 hours, or almost exactly 0.02 second-foot, this being the amount delivered under a 4-inch head, measured from the center of the opening. Under this assumption 1 second-foot should irrigate from 250 to 500 acres. This is on the basis of delivering the water in pipes or cemented channels in the immediate vicinity of the trees or vines to be irrigated. If it be assumed that 1 miner's inch is allowed for 10 acres, or 1 second-foot for 500 acres, this quantity of water flowing from May to October, inclusive, will cover the ground to a depth of a little over seven-tenths of a foot, or 8.8 inches. This quantity, with the care and cultiva-

* From Twelfth Census.

tion usually bestowed, has been found to be sufficient.

The method of applying water largely governs the amount used. In the case of alfalfa, flooding is practised; with small grains the water is run in furrows; while in the case of orchards the water is sometimes applied directly to each tree. In this case a little earth basin about 6 feet or more across and 6 inches deep is formed around each tree and partially filled with water. The better way, however, is that of running water in furrows, four or five of these being plowed between each two rows of trees. The water is applied very slowly, several days being spent in the process, and when dry the ground is thoroughly cultivated. The annual charges for water by the acre in southern California, where this economy of water is practised, have been as low as $3, and from this rising to $15 or more per acre.

For good farming in parts of the arid region outside of southern California, a depth of from 24 to 30 inches of water during the crop season should be sufficient, except in the case of alfalfa and other forms of forage which are cut a number of times. The temperature and the wind movement introduce so many conditions that broad statements of this kind are merely suggestive, and not to be followed as rules.

WASTE OF WATER.

Where an excessive amount of water is put upon irrigated land, as high as 70 per cent has been known to pass by seepage to the lower grounds. With care this amount could have been reduced in quantity and the time and labor consumed in handling this excess could have been saved.

Growing plants evaporate in many cases 300 times their own weight of water each year. If a crop be carelessly cultivated and weeds allowed to grow with plants, the worthless plants waste as much water as is used by those that are valuable. On the other hand, with careful cultivation, by destruction of the weeds, and by keeping the top soil well pulverized, the evaporation is lessened and the waste of water is prevented. The loose, dry soil on top, with many air spaces, breaks up the capillary tubes of the soil and reduces to a minimum the losses by evaporation. Under these conditions, the quantity of water required is only one-half or one-third of the amount needed where the farming is carelessly done.

The first settlers frequently laid claim to the whole flow of the stream and built a ditch, small at first, taking only enough water to supply the land which could be cultivated during the first year or two. Later, as more land was brought under cultivation, the ditch was enlarged and more water was taken from the stream as it was needed. Soon after the first ditch was built others were constructed a few miles above or below the first, the owners usually claiming all the water to be had at the particular point where the headworks were located. As long as the stream is of sufficient volume to fill each of the ditches, no difficulties arise; but sooner or later the increasing size and number of ditches and canals result in diminishing the flow in the river to such an extent that it becomes low, and water does not reach the ditches farthest downstream. This scarcity of water becomes apparent during the latter part of the crop season, in July and August, when the streams are lowest and the need of water is greatest.

The owners of the ditches first built are entitled to priority of right in the use of the water. Seeing the crops wither and the orchards die for lack of water, they are tempted to take desperate measures to enforce their rights, sometimes tearing out upper dams in the river and releasing the water. Thus in many parts of the arid region, owing to scarcity of water, lawlessness has prevailed and every man has endeavored to obtain for his own crops as much as possible of the scanty supply.

It has usually been found necessary for the irrigators to elect one of their number to serve for a season as water master, and to apportion to each claimant a certain amount of water, or assign certain days and hours upon which water can be used. The water master, or ditch rider, as he is sometimes called, must, when the supply is scant, go along the canal and see that the various head-gates are closed or opened to receive the determined quantity of water, locking these so that they can not be tampered with after he has left. Often the quantity of the water has been settled only after vexatious lawsuits or neighborhood quarrels, and great care and tact is required to preserve friendly relations during times of scarcity, when some crops must be left to wither under the intense summer heat in order to save others whose owners enjoy older or prior rights. In some parts of the arid region, notably in Wyoming and Colorado, the States have undertaken the regulation of disputes, and have created special boards or tribunals to consider the matter and apportion water. In Colorado, where the State is divided into districts, each embracing a single stream, the regulation of the waters is intrusted to a State official known as a commissioner. The districts are grouped together to form divisions corresponding with the principal catchment basins. Each division is under the charge of a superintendent, who supervises the work of the commissioners. Superintendents in turn are under the State engineer. It is the duty of these officials to regulate the head-gates in time of scarcity, cutting off water from the new ditches in order that the older claimants may be supplied, following the decrees made by the courts as to the order of priority and the amount of water to which each ditch is entitled.

WATER FROM WELLS.

In the arid region water can be obtained frequently by digging or boring wells at points near stream channels or along the foothills. Out on the broad valleys it may be necessary to go to a depth of from 100 to 300 feet or more before reaching moisture. Where the supply of water from wells is ample, various devices have been employed, such as windmills, and gasoline engines, for bringing it to the surface.

The quantity of water is dependent upon certain geological conditions, the sands and gravels usually being saturated, and delivering water freely to any cavity made in them. It is very important to continue the borings through the water-bearing sands or gravel, so as to take advantage of the full thickness of the pervious deposits. Perforated pipe is often driven into the layers of coarse gravel, and adds greatly to the capacity of the well.

Provision must be made for a free passage for the water from the material in which it occurs. This is sometimes done by driving galleries or tunnels from the bottom of a well to intersect coarser deposits laid down in ancient stream channels. These collecting galleries serve to bring small quantities of water toward a center from which they can be pumped. Work of this character is hardly practicable for ordinary farm or domestic supply, but has been successfully undertaken by towns and small cities in the West. With the development of population and the increase in value of water, it is probable that investments of this character may be profitable for some forms of irrigation.

Artesian, or flowing wells, may be sunk wherever water held under pressure in pervious material is overlaid by clay. In a well dug through the impervious layer into the gravel the water will rise to a height equal to the line of saturation of the gravel stratum in the surrounding country. If the beds of alternating clay and gravel are inclined or tilted, as a result of earth movement, water follows down under the clay or impervious shale. The impervious stratum holds the water down until pierced by a well. The term "artesian" is applied to wells in which the water rises to a height sufficient to overflow the surface of the ground. There is no commonly accepted designation to cover the case of wells in which the water rises but does not overflow, this being characteristic to a greater or less extent of nearly all artificial openings in the ground.

Artesian conditions occur in nearly every State, but they do not extend over any considerable portion of the country, excepting on the Great Plains and in California. Wherever they occur the water has especial value on account of the convenience incident to its rising above the surface. In some places, as the James River Valley of South Dakota, the pressure is 100 pounds or more to the square inch, throwing the water to a considerable height and enabling the wells to be used as sources of power.

The quantity of water to be had from deep wells is governed by the diameter of the well, the structure and thickness of the water-bearing rocks, and the pressure sustained by the water. With relatively dense rocks a slight head of water will throw only a feeble stream, but from thick layers of open gravel or sand rock large volumes are delivered. The pipe of the well is usually from 2 to 6 inches in diameter, averaging about 4 inches. It is not to be supposed, however, that by increasing the diameter a correspondingly large amount of water will be obtained. It frequently occurs that a 4-inch pipe will deliver all of the water which can reach this point, and increasing the diameter of the well will not alter the flow.

The source of water coming to artesian wells may be at a distance of several miles or several hundred miles. The large amount obtainable in eastern South Dakota has probably traveled underground from the eastern front of the Rocky Mountains or from the Black Hills—a distance of from 200 to 500 miles. The area of rock thus saturated may aggregate many hundred square miles, and the volume stored underground is thus very large. On the other hand, an artesian basin may be quite small, receiving only a small supply from the annual rainfall, the water-bearing rocks outcropping in the near vicinity of the well. One or two wells drilled into this basin do not appreciably diminish the pressure or flow, but as the number is increased the stored water is drawn upon more rapidly than it can be replenished, and the pressure diminishes until the wells no longer flow. A condition of this kind has occurred in the artesian basin in the vicinity of Denver, Colo. All of the wells within or near the city have ceased flowing, and water is obtained from them by pumping; in a more remote portion of the basin, however, some of the wells still flow. Diminution of pressure has not been observed in the larger artesian basins, such as those in the San Joaquin Valley of California, the Moxee Valley of Washington, the James River Valley of South Dakota, and the San Luis Valley of Colorado.

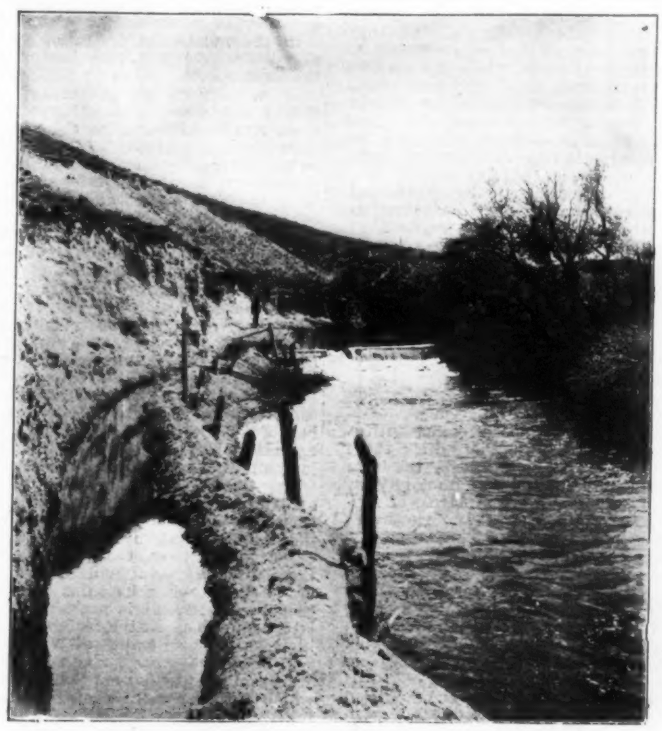
Some artesian wells have decreased or stopped flowing, not from the lack of water, but because of mechanical defects in their construction. Fine sand has accumulated, stopping up the well, or the tubing or casing has rusted away, permitting the water to escape into pervious rocks below ground. In the construction of artesian wells it is highly important to provide suitable casing to prevent the water from escaping into the dry rocks, and in short, every precaution should be taken to prevent waste of water or destruction of other wells through the careless management of one or two.

The amount of water delivered by an artesian well varies from a few gallons a minute to 5 cubic feet per second, or even more. Wells flowing 1 cubic foot per second have great value in irrigation, as by storing this water 100 or 160 acres can be watered.

The owner of a well is independent, and can use water when and where he wishes, while the irrigator depending upon a ditch system must be governed by the needs of other persons. Artesian well water is free from seeds of weeds and is usually somewhat warmer than the ground, so that it does not chill the plants, as is sometimes the case with water from mountain streams.

PUMPING DEVICES.

Most of the water used in irrigation is diverted by gravity from flowing streams. While this is true regarding the quantity of water, yet, as regards value, it may be said that some of the most important sources of supply are utilized through pumping. In some localities, where horses have little value, pumping by horse power is in vogue. The practicability of irrigation in this way is limited largely by the depth of the water, and the number of animals available.



HEAD OF SMALL DITCH, WYOMING.

The force of flowing water itself is frequently employed to bring water up to the level of the irrigable land, the bucket wheel having been utilized from the earliest historical times up to the present. This consists of a large paddle wheel, sometimes 30 feet in diameter, with a series of buckets so arranged around the rim that when the wheel revolves by the force of the current the buckets are filled, raised to the top, and emptied into a trough which conducts the water into the irrigating ditches. Wheels of this kind are to be seen upon many of the rivers of the West. Where there is sufficient fall in a stream to develop water-power, various standard forms of water wheels can be used to operate pumping machinery. Such devices are occasionally employed to obviate the necessity of building expensive lines of canal, the power of a stream being used to pump the water to the top of a high bank, which otherwise could be surmounted only by many miles of canal with costly flumes and tunnels.

The most important source of power for pumping water is wind. Over the broad valleys and plains of the arid region the wind movement is almost continuous for days and weeks. In some localities in this region, at depths of 20 to 50 feet or more beneath the surface, pervious beds of sand or gravel are filled with waters by the infiltration of rainfall, or by percolation from stream channels. It is a comparatively simple and inexpensive operation to sink a well into this water and erect a windmill, attaching this to a suitable pump.

A windmill once erected on the plains is operated day and night by the ever present wind, bringing to the surface a small but continuous supply of water. This small stream, if turned out on the soil, would flow a short distance, then disappear into the thirsty ground, so that irrigation directly from a windmill is usually impracticable. To overcome this difficulty it has been found necessary to provide small storage

reservoirs or tanks built of earth, wood or iron, to hold the water until it has accumulated to a volume sufficient to permit a stream of considerable size to be taken out for irrigation. Such a stream flowing rapidly over the surface will penetrate to a distance and cover an area much greater than is possible with the small flow delivered by the pump.

The windmills employed in irrigation are of all kinds, from the crude homemade devices to the highest type of the machinist's art. Sometimes as many as half a dozen mills are placed around a tank of this kind, as a number of small mills usually give better results than one or two large ones. When the diameter of the wheel is increased much above 10 or 12 feet, the length is considerably diminished and the liability to injury during a storm is greatly increased. Small, rapid-running wheels 8 to 12 feet in diameter have therefore been found most economical. If one is injured, the others will continue pumping.

One disadvantage connected with the use of wind mills is that most of them are constructed to operate only in moderate winds. A very light breeze may not start the wheel in motion. As the strength of the wind increases the wheel begins to revolve, increasing in efficiency until the velocity of the wind is about 8 or 10 miles an hour. At greater speed the mills are usually so constructed that the efficiency decreases rapidly as the wind becomes more powerful. When it approaches a gale the mill stops completely, and thus, at the time when, with sufficient strength of construction, the greatest amount of water could be pumped, the machine stands idle.

DRAINAGE.

In many places in the United States drainage works are a necessary adjunct of irrigation. On bench lands or gently sloping hillsides the water which escapes from one man's farm is eagerly caught and used by his neighbor below, and there is none left to stagnate, the surplus from the cultivated lands being often of great value in watering the lower meadows. There are cases, however, where the question of disposing of the water is as important as that of obtaining it. These are on the nearly level lands, where the surplus water is at too low an elevation to be employed again, and must stand until evaporated. Here the subsoil has been filled to saturation by the water which has no opportunity to escape, and expensive works are required in order to redeem the lower lands for agricultural purposes.

For example, in Utah county, Utah, the water used upon the higher benches has by percolation saturated the soil of the lower lying land to such a degree that in the wide, nearly level tracts about the borders of the lake, where once farming was possible, there are now broad marshes suitable only for meadows. The progress of the water can be seen each year. In the spring many of these tracts do not appear to be wet, but as the season advances they become more and more swampy until large areas are practically valueless except for occasional grazing.

DUTY OF WATER.

The amount of land which can be irrigated with a given quantity of water, or the relation which these bear to each other, is commonly expressed by the term "duty of water." The investigation of the duty of water is one of the most complicated problems of irrigation, on account of the diversity of conditions and the difficulty of procuring facts. There is such a difference in methods of measurement, localities, soils, crops, application of water, and frequency of watering that the statements made by different persons are almost irreconcilable. In general more water is used, or, in other words, the duty is less, on the newer land than on that which has been cultivated by irrigation for some years, and more is used where water is plentiful than where it is scarce.

Many experiments on the duty of water have been made during recent years by the Agricultural Experiment Stations and by a few individuals. These show actual results under given conditions. The statement of the duty of water should indicate the point at which the measurement is made. If water is measured at the edge of the field where it is used, the duty will appear to be much higher than if measured at the headworks of the canal, owing to the large loss which usually takes place in flowing from the headworks to the fields.

Farmers are accustomed to judge by the eye as to the quantity required, and this, consequently, is as varied as the individual opinion. Where water is plentiful each man takes what he wishes; where scarce, he takes all that he can get. The more sandy the soil the more readily it receives water, and the more apt the farmer is to apply it in large quantities; while with clay soil, saturation proceeding much slower, far less water is usually applied.

The rainfall also affects the quantity used, and as this is exceedingly irregular, the amount of water applied each year fluctuates. Seepage also complicates matters, for a field may often receive considerable water indirectly and require less by direct application.

The duty of water is quoted at from 30 to 600 acres or more to the second-foot. For convenience the unit of 100 acres to the second-foot has been considered as indicating careful irrigating, although in the more southwestern portion of the arid region this would be considered low, and in the northern part, high.

Value per Second-foot.—Since the value of water per second-foot varies largely with its duty, it will be recognized that it is exceedingly difficult to estimate. However, it is necessary to arrive at certain averages in order to approximate the possible values of river, or of storage basins, in the future development of the country. It has been estimated that a perpetual water right is worth from $25 to $50 per acre in a grain or grazing country, and as high as from $100 to $500 per acre for fruit land, rising in southern California for the best citrus lands even to $1,000 or more per acre.

ALKALI.

The accumulation of alkali in irrigated land presents one of the most serious problems encountered in this method of agriculture. The injuries from the presence in excess of earthy salts are usually evident in the corrosive action on the tender bark, especially at the root crown. There is great difference among the various plants and trees in their power to withstand the action of alkali. There are a number of chemical compounds which enter into what is known as alkali, and to understand properly the utilization of alkali land it is necessary to know the composition of the alkali, and to ascertain whether it consists chiefly of carbonates (black alkali), sulphates, or chlorides such as common salt. It is important also to know whether the alkali is distributed uniformly through the soil or is concentrated near the surface, or at lower points. The total amount of alkali which is within reach of the plants must also be determined.

The most effective way of removing alkali is by underdrainage through tiles, laid at a depth of from 3 to 5 feet, the drainage water being allowed to escape into a stream or into a well, from which it can be removed by pumping. It has been found practicable to wash soil in this way and remove the excess of alkali, reclaiming valuable tracts.

Experiments made in California show that apple trees are severely injured by the presence of 3,000 pounds of common salt per acre, this amount being disseminated through 4 feet in depth. On the other hand, the olive thrives at Tulare, where the soil contains as high as 5,600 pounds of salt per acre. Alfalfa, when young, is easily killed by alkali, but it has been found to thrive in soil containing as much as 6,000 pounds of common salt, 3,000 pounds of carbonate, and over 1,000 pounds of sulphate, per acre, distributed through 6 feet in depth. Sugar beets also have been known to grow well where a large amount of alkali is present. Grapes apparently are least affected by small amounts of alkali, while peaches and lemons are more susceptible to injury because of its presence. The recently introduced salt bush is notable for its ability to grow in alkaline lands, and sorghum and alfalfa, especially when the latter has reached maturity, are almost equally vigorous.

In the number of irrigators California stands far ahead of any other State, having about one-fourth of the total number in the United States. Colorado, however, exceeds in the number of acres irrigated, although not in the value of irrigated crops. In this respect California leads, having a value double that of Colorado, and over one-third that of the total value of irrigated crops in the United States. The greatest percentage of increase in the number of irrigators has been in Washington, and the least in the adjacent State of Oregon. This, doubtless, is due to the fact that Oregon reached a certain point of culmination in irrigation advancement previous to 1889, while in Washington the construction of ditches had only begun. If we take the increase for the United States as the normal condition—that is to say, consider that for any given locality the number of irrigators should have doubled to show a normal growth—then it will be seen that in the States of Oregon, Nevada, Colorado, Utah, California, and Wyoming the growth has been less than normal, while in the States of Idaho, Montana, New Mexico, and Arizona the increase in number of irrigators has been above the normal. Some exception may be taken to this statement, particularly in the case of New Mexico or other localities where there has been a difference in the definition of an irrigator, or where, on account of communal conditions, it has been impossible to ascertain the exact number of irrigators; that is to say, taking a Mexican or an Indian town, the question arises as to whether the community as a whole shall be considered as one, or whether each able-bodied man shall be considered as an irrigator. It is probably due somewhat to this latter difference that New Mexico shows such a large increase in the number of irrigators.

Taking in the same way the increase in number of acres irrigated, it is seen that California and Colorado, which together include only one-half of the acreage irrigated, have fallen behind the normal or average growth of acreage brought under cultivation by the artificial application of water; while on the other hand the remaining States and Territories have increased abnormally, development being least rapid in Oregon; greater in New Mexico, Nevada, Utah, Wyoming, Montana, Washington, Idaho; and greatest in Arizona.

In considering the character and value of the crops produced on irrigated land in the arid States and Territories, hay and forage form the most important item, being over one-third of the whole. Cereals—principally wheat, oats, rye, and barley—come far below the forage crops; and next to these in order are vegetables, orchard fruits, and small fruits. In only one State—California—do the orchard fruits surpass the forage crops in value. It is noteworthy that in this State the cereals are now fourth in order of importance among the irrigated crops.

The large production of hay and forage under irrigation illustrates the fact that in these States irrigation is, to a large extent, an adjunct of stock raising. The largest amount raised is in Colorado, California coming next in importance, being followed, in the order given, by Montana, Utah, Idaho, Nevada, Oregon, Wyoming, New Mexico, Arizona, and Washington.

The production of cereals under irrigation is relatively small. In California, for example, only 6.0 per cent of the wheat is irrigated, and 8.0 per cent of the barley. The total value of all the cereals produced under irrigation in the United States is far less than that of those produced in almost any one of the humid States of the East; in New York, for example, though it is not considered a farming State, the value of the cereals raised is more than double that of the entire amount produced under irrigation in the whole country. In many localities the irrigation of cereals and staple crops has been brought about by local conditions, such as difficulty of transportation and consequent heavy cost of importation. The irrigated cereals in such localities are raised almost wholly for local consumption, and do not enter the markets of the world.

The most important function of irrigation, next to raising hay and forage for the winter feed of cattle on the public range, is the production of vegetables, fruits, and miscellaneous crops.

TRADE NOTES AND RECIPES.

Production of "Roseine," a Cheap Alloy for Jewelry—Roseine, an alloy for cheap jewelry, is composed as follows:

Nickel	40 parts
Silver	10 parts
Aluminium	30 parts
Tin	20 parts

Owing to its peculiar composition, roseine can be classed with none of the known large groups of alloys.

The alloy can be worked in any manner, has a handsome white color, and is chiefly used for the manufacture of low-priced jewelry.—Metallarbeiter, Vienna.

In the Opinion of the Druggists' Circular and Chemical Gazette certain of the petroleum oils are better adapted for the lubrication of sewing machines than any of the animal oils. Sperm oil has for a long time been considered the standard oil for this purpose, but it is really not well adapted to the conditions to which a sewing machine is subjected. If the machine were operated constantly or regularly every day, probably sperm oil could not be improved on. The difficulty is, however, that a family sewing machine will frequently be allowed to stand untouched for weeks at a time and will then be expected to run as smoothly as though just oiled. Under this kind of treatment almost any oil other than petroleum oil will become gummy. What is known in the trade as a "neutral" oil, of high viscosity, would probably answer better for this purpose than anything else. A mixture of one part of petrolatum and seven of paraffin oil has also been recommended.

New Process for Soldering Cast Iron.—According to Prof. Rudeloff of the Mechanico-technical Experimental Station at Berlin, who has tried this new process, which is patented in Germany, it enables one to do soldering which is not inferior in strength to the cast iron itself. The process consists in decarbonizing the surfaces of the cast iron to be soldered, the molten hard solder being at the same time brought into contact with the red-hot metallic surfaces. The admission of air, however, should be carefully guarded against.

First pickle the surfaces of the pieces to be soldered, as usual, with acid and fasten the two pieces together. The place to be soldered is now covered with a metallic oxygen compound and any one of the customary fluxes. Then heat is applied until red hot.

The preparation best suited for this purpose is a paste made by intimately mingling together cuprous oxide and borax. The latter melts in soldering and protects the pickled surfaces as well as the cuprous oxide from oxidation through the action of the air.

During the heating the cuprous oxide imparts its oxygen to the carbon contained in the cast iron and burns it. Metallic copper separates in fine subdivision. Now apply hard solder to the place to be united, which in melting forms an alloy with the eliminated copper, the alloy combining with the decarburized surfaces of the cast iron.—Neueste Erfindungen und Erfahrungen.

Production of Gilder's Wax.—For the production of various colorings of gold in fire gilding, the respective places are frequently covered with so-called gilder's wax. Same consists of mixtures of various chemicals which have an etching action in the red heat upon the bronze mass, thus causing roughness of unequal depth, as well as through the fact that the composition of the bronze is changed somewhat on the surface, a relief of the gold color being effected in consequence of these two circumstances. The gilding wax is prepared by melting together the finely powdered chemicals with wax according to the following recipes:

	I.	II.	III.	IV.	V.
Yellow wax	32	32	32	96	36
Red chalk	3	24	18	48	18
Verdigris	2	4	18	32	18
Burnt alum	2	4	—	—	—
Burnt borax	—	—	2	1	3
Copper ash	—	4	6	20	8
Zinc vitriol	—	—	—	32	18
Green vitriol	—	—	—	1	6

—Metallarbeiter, Vienna.

Household Ammonia.—Various formulas for household ammonia and kindred preparations have been published from time to time. Household ammonia, says the Pharmaceutical Era, is simply diluted ammonia water to which borax and soap have been added. To make it cloudy add potassium nitrate or methylated spirit. The following are good formulas:

1. Ammonia water ....16 parts
   Yellow soap ....64 parts
   Potassium nitrate ....1 part
   Soft water, sufficient to make ......200 parts

Shave up the soap and dissolve it in the water by heating, add the potassium nitrate and dissolve. Let cool, strain, skim off any suds or bubbles, add the ammonia, mix, and bottle at once.

2. Stronger solution of cloudy ammonia:
   Methylated spirit ....1 part
   Stronger ammonia water........1 part
   Soft water ....2 parts

Mix.

3. The best quality:
   Alcohol, 94 per cent........ 4 ounces
   Soft water .... 4 gallons
   Oil of rosemary........ 4 drachms
   Oil of citronella........ 3 drachms

Dissolve the oils in the alcohol, and add to the water. To the mixture add 4 ounces of talc (or fuller's earth will answer), mix thoroughly, strain through canvas, and to the colate add 1, 2, or 3 gallons of ammonia water, according to the strength desired, in which has been dissolved 1, 2, or 3 ounces of white curd, or soft soap.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Briquette Machinery for America.—The correspondence received during the past month from nearly every State and Territory of the Union, making inquiry concerning the machinery and processes employed in Germany for making fuel briquettes from lignite, peat, and coal dust, indicates that public interest in the whole subject of utilizing the hitherto wasted or neglected fuel materials, so abundant in America, has been thoroughly aroused. There are in New England, western New York, Michigan, Illinois, Wisconsin, Oregon, and Washington vast beds of peat which have been thus far hardly explored. There are in the Dakotas and the Gulf States large deposits of lignite and material midway in character between lignite and peat, and there are in all the coal mining States enormous quantities of bituminous dust and anthracite culm, all of which may by the employment of modern machinery and processes be added to the fuel supply of our country.

This is an industry in which the first tentative efforts made in the United States have generally failed, but which has been developed in Germany, France, and Belgium by long, careful, scientific experience into an important and successful system of production. There is no reason why an American operator or mine owner should risk a dollar in vague or hazardous experiments; he has only to ascertain by expert inquiry what his crude material contains—whether or not it is adapted to profitable conversion into briquettes, and, if so, by what processes and machinery it can be most effectively treated. With a view of answering concisely the latest inquiries on this subject and simplifying to some extent the practical proposition, the following résumé of the briquette manufacture, as it exists in Germany, is respectfully submitted.

German briquette factories are divided, in respect to the crude material employed, into two general groups—those which make household briquettes from brown coal (lignite) or carbonized peat; and those which produce the so-called "industrie briquettes," using as basic material coal dust or "slack," the waste of bituminous coal mines.

I. Household briquettes, as made in Germany from brown coal, peat, and to some extent from anthracite dust, are used for grates, heating stoves, cooking stoves, and ranges, and constitute the principal household fuel of Berlin and other German cities. They are clean to touch, kindle readily, burn with a clear, full flame, and are cheaper in Berlin, ton for ton, than anthracite or good bituminous coal. They are made—largely from brown coal—in factories located mainly in Silesia, Saxony, and the Rhine provinces, and united in a syndicate, which controls the output, regulates prices, and looks after the general welfare of the industry.

Machinery for the manufacture of briquettes from lignite is made by several large establishments, among which may be cited the Zeitzer Eisengiesserei, at Zeitz, in Saxony; the Maschinen Fabrik Buckau, at Magdeburg; and the Königin Marienhütte, at Cainsdorf, in Saxony.

There are in Germany 439 brown-coal mines, which produced last year 44,211,902 tons of lignite, valued at $46,042,500, or a little more than $1 per ton. Of this whole number of mines, 181 have each from one to six briquette factories, in each of which from one to ten presses are employed. The whole brown coal briquette industry of Germany includes 286 factories, with a total of 691 presses. Statistics of the total yearly product are not accessible, but from the fact that a single press turns out from 50 to 90 tons per day, it will be readily inferred that the annual output is enormous. They are the standard household fuel throughout a large portion of this country, and are besides largely used for firing steam boilers, especially in cities, where their cleanliness and freedom from smoke and dust are highly esteemed. The standard household briquette is about 8 inches in length by 4 inches in width and 2 inches thick, and is retailed and delivered in Berlin at prices ranging from $2 per 1,000 in summer to $2.50 in winter.

II. Industrial briquettes are used in Germany for firing locomotives and other steam boilers, for smelting in reverberatory furnaces, and for many other kinds of industrial heating. They are made of bituminous coal dust, held together by a matrix of mineral pitch—that is, coal tar derived from retort coke ovens or gas manufacture, and from which the benzole and other valuable elements have been eliminated. Pitch of this quality costs in this country from $10 to $12 per metric ton.* The percentage of matrix necessary to be used varies greatly with the "fatness"—i.e., richness in bituminous elements of the coal itself. Slack from very fat coal will work into briquettes with an addition of 2 or 3 per cent of pitch, while leaner grades may require 6 to 8 or even 10 per cent, the latter proportion being sufficient, at the present cost of pitch, to render such coal unprofitable for briquette making purposes. Briquettes made from bituminous slack, although not smokeless, are much more nearly so than ordinary bituminous coal. When burned in locomotives or any well-constructed boiler or other furnace with a good draft, they create only a thin, translucent mist, which contains relatively little soot, and is very different from the inky clouds that roll up from most factory chimneys where soft coal is shoveled indiscriminately into the furnaces. The one notable defect of such briquettes is that the mineral pitch, which is used as a binder, contains more or less creosote; this renders dust and fumes from such fuel acrid and sometimes irritating to the skin when confined in a close hot boiler room. Soft coal briquettes are made from the dust and waste of mines, and when the composition of the coal is such as to permit a low percentage of binder to be used, they are the cheapest and easiest kind of briquettes to produce. They are made in machine presses more or less similar to the Zeitz pattern, with a capacity of 90 tons of briquettes per day.

The output of soft coal briquettes in western Germany is controlled by a syndicate called the Briquette Sale Syndicate of Dortmund, which includes among its members 31 factories, located in Westphalia and the Rhine provinces. These establishments employ, collectively, 112 machine presses of the Couffinhal type, besides 1 French machine of the Bourriez model and 3 so-called "egg-rollers," or machines, which produce small, oval briquettes of egg size which are burned in certain kinds of tubular boilers. The syndicate claims a maximum annual capacity of 2,100,000 tons, and as its official report shows, makes about three-fourths of that amount—whatever the market will take at prices which the syndicate managers consider equitable. Industrial briquettes are usually of a square or oblong form, convenient to be closely packed or built up into a wall, like bricks, whereby they greatly economize space as compared with raw coal. They range in weight from 3 to 10 pounds, and each bears the initials or trade-mark of the company by which it is produced, so that in case of any defect in quality the inferior briquette can be readily traced to its source of production. When burned whole, they are consumed slowly and give out a steady, moderate heat for a long time; when it is desired to quicken or intensify the flame, they are broken up, and in this condition are especially adapted to flue or tubular boilers, sugar evaporating, smelting, and annealing furnaces, in glass manufacture, or in porcelain and cement factories, wherever, in fact, a fuel capable of producing a long, fierce flame is desirable. Their efficiency as locomotive fuel may be inferred from the fact that the State railways of Prussia, which used 130,000 tons of such fuel in 1889, have bought from the syndicate 680,000 tons during the first nine months of 1902.

Anthracite coal is so sparingly produced in Germany that the use of hard coal dust for briquette making is relatively unimportant. Experts, however, agree that with an admixture of from 4 to 8 per cent of matrix, the manufacture of anthracite briquettes, which will bear transportation by sea or land in any climate, presents no technical difficulty.

As has been indicated in previous reports, the manufacture of coke and briquettes from peat or turf is still relatively in the experimental stage, although there are several factories in successful operation and another—largest of all—is just being put into operation at Königsberg, on the Baltic coast of East Prussia.

III. As a result of the present widespread interest in this subject and the many inquiries that have been received from mine owners and operators for technical information as to processes, cost, and capacity of machinery, etc., a combination has been formed between three of the foremost machine builders in this country, whose products collectively include all the necessary apparatus for making briquettes from coal dust, brown coal, and peat. The purpose of this syndicate is to meet promptly and efficiently the American demand for machinery and working methods which represent the best results obtained by scientific study and mature experience in Germany. The combination is entitled "The Export Syndicate of Briquette Machinery Manufacturers," with central office at No. 59 Friedrich Strasse, Berlin, and includes as members the Zeitzer Eisengiesserei at Zeitz, Saxony, the Maschinenfabrik Buckau at Magdeburg, and the Maschinenfabrik (formerly Jaeger) at Ehrenfeld-Cologne. Its plan is to send over, within a few weeks, an experienced engineer, who will establish an office at New York and be prepared to confer with firms and persons who contemplate entering upon the manufacture of briquettes, to examine sites and materials, make plans and estimates for buildings, machinery, etc. An opportunity will be thus offered for American mine owners and operators to ascertain definitely in advance the theoretic value of their material for briquette making, and the cost of a plant of a given daily capacity.

Meanwhile, the same results can be reached with important saving of time if owners of coal mines or lignite beds will send to the above address, directly, or through this consulate, 10-pound samples of their material in the exact condition in which it will be available in large quantities for practical use. The percentage of water in any briquette material is an important factor in determining how it can best be worked.

If the material is dry—as, for instance, slack from a well-drained bituminous coal mine—the sample may be sent in an ordinary box or package. If, on the other hand, the slack or culm is obtained wet from a washing process, or if the material is lignite or peat from a bog, the sample should be sent in a tight tin case, which will preserve the exact percentage of moisture which will be encountered when it is mined for use on an industrial scale.

The postal package treaty between the United States and Germany provides for the transmission by post, reciprocally, of packages not exceeding 5 kilogrammes (about 11 pounds avoirdupois) in weight at a uniform rate of 12 cents per pound. Allowing for the weight of the necessary covering, this will enable interested persons in America to forward to Berlin samples of their material sufficient in quantity to be analyzed, submitted to various tests and even made experimentally into briquettes; so that its adaptability to briquette manufacture, the percentage of binder required, the caloric value of the product, and methods and machinery best adapted to working it can be ascertained and reported on in advance, by responsible experts who are prepared to follow up their estimates by practical operations.

In this way, the technical experience and scientific knowledge which have made the briquette industry successful and important in Germany will be made directly available by American operators who desire to begin at the point of economic efficiency that has been attained by the best practice in Europe.—Frank H. Mason, Consul-General at Berlin.

* 1 metric ton = 2,205 pounds.

American Trade in India.—Consul W. T. Fee transmits from Bombay, November 20, 1902, a clipping from the Times of India, which reads, in part:

THE AMERICAN INVASION.

Already there are signs, very distinct, if at present small, that the Americans have commenced their invasion of the commerce of this country in earnest. To every department of commerce America is contributing her quota, and the local bazar exhibits unmistakable signs that her intention is not merely a casual experiment. She is not merely feeling her way, but has already laid down the foundation of a thriving and prosperous business. American agents are fully alive to the possibilities of the country, and, as the Indian Textile Journal points out in its current issue, the probability that American capitalists will look to India as a future field for industrial speculation is not far remote. Whatever else may be said of American competition, it is always fair and always legitimate. It does not result in a market flooded with goods of the cheap and nasty order; it does not arise out of methods risky and speculative, so far as the manufacturers themselves are concerned. American success is due to pluck, enterprise, and inventiveness, helped by skill in manufacture and worth in her productions. There was a time when the native dealer scorned to take advantage of American prices, simply because he preferred to stand by the merits of the British-made articles, quite apart from the question of cost. That day has gone by. The American has within a few years secured 5 per cent of Indian trade and the Indian bazar, so far as the steel industry is concerned. Were it not for the fact that the British manufacturer is so helped by official influence, the slump in the direction of America would be rapid. It is not to be expected, when the articles are placed side by side, both equally good but one cheaper than the other, that the purchaser will not choose that which costs him less money. Improvement in system at home will simply mean Americanizing. Surely, as the Textile Journal hints, British manufacturers are too astute to lose trade and lose money merely for the sake of tradition and prejudice.

Oil Motors in India.—Under date of November 21, 1902, Consul W. T. Fee, of Bombay, sends an article from the Indian Textile Journal, of that city, from which the following extracts are taken:

There has been much talk in India during the last year or two of the oil motor, but apparently the question is a difficult one. In a city like Bombay, badly served as it is with electric power, an inexpensive motor, giving just sufficient power for installation of electric light, would be invaluable. In a very short time, there will be received in Bombay a consignment of small kerosene-oil motors. The special advantage of the motor is that it is free from complicated parts and no boiler is required. A Bombay client of an American firm has ordered a 21-foot kerosene-oil launch for the harbor, and it is stated that this little vessel will put to shame most of the clumsy-looking craft which one sees in the harbor. This launch is fitted with one of the above motors, which have the additional advantage of being convertible into marine engines with very little trouble.

Inquiries for American Shotguns and Ammunition.—Consul G. H. Jackson reports from La Rochelle, November 18, 1902:

There have been received at this office several inquiries concerning American sporting arms. The shotguns most in use here are light weapons, weighing from 5 to 7 pounds. The ammunition is used to hunt partridges, quails, little bustards, and waterfowl. The market is supplied at present with French guns, as well as with many from Belgium and a very few from England. Catalogues and price lists should be sent to E. Bertrand, 28 Rue Chaudrier, La Rochelle.

American Yacht Wanted in France.—Consul G. H. Jackson reports from La Rochelle, December 5, 1902:

A French gentleman has asked me to put him in communication with somebody who has an American-built auxiliary wooden yacht to sell. It should have a good beam and be a good sea boat, comfortably installed for cruising; measurement, from 150 to 200 tons. Other conditions being equal, vessels already in European waters would have the preference; the boat must be American built. Descriptions, prices, and all other information should be sent to this office, addressed to the United States consul.

Bounties for Siberian Butter.—Consul S. Smith, of Moscow, November 27, 1902, writes:

The Department of Agriculture has allotted 78,000 rubles ($39,000) to increase the export of Siberian butter. This amount will be distributed as follows:

1. To increase the number of instructors for creameries in western Siberia.
2. To maintain creamery schools in Kurgan and Omsk provinces.
3. To maintain educational courses in creamery economy.
4. To organize creameries in western Siberia.
5. To maintain one central and five examining laboratories.
6. Traveling expenses of instructors and foremen.

Scarcity of Wheat in Australia.—Consul-General J. P. Bray reports from Melbourne, November 3, 1902, that there is a serious shortage in the grain yield of Australia, and that in consequence numerous inquiries are being made at that consulate-general with regard to imports of wheat from the Pacific coast. Many shipments of American wheat have already been arranged for.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1531. December 29.—*Commercial Conditions in Asiatic Turkey.

No. 1532. December 30.—American Capital in Canadian Bank Stock—Nottingham Lace Trade—Sugar Crop in Santiago de Cuba—*American Trade in India—*Oil Motors in India—*American Yacht Wanted in France—*Inquiry for Furniture in Russia—Commercial Navigation Department in Russia.

No. 1533. December 31.—*Opening for an American House in Bangkok.

No. 1534. January 2.—Failure of Australian Wheat Crop—*Advice to Exporters to Scotland—New Japanese Steamers.

No. 1535. January 3.—Commercial Notes from Italy.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Cheap Perfumes.—

Violet Perfume.

Artificial musk	1 gramme
Vanillin	2 grammes
Coumarin	2 grammes
Ylang-ylang oil	3 grammes
Bergamot oil	7½ grammes
Iris liquid	12½ grammes
Neroli oil	½ gramme
Extract jasmin	300 grammes
Extract rose	200 grammes
Extract cassie	50 grammes
Infusion benzoin (1:2)	50 grammes
Genuine rose oil	10 drops
Spirit 96 per cent	9.3 liters

Florida Water.

Spirit, 96 per cent	3½ liters
Rose water	1 liter
Linaloe oil	40 grammes
Clove oil	28 grammes
Lemon gras oil	14 grammes

Pomades.—

Rose Pomade.

Vaseline oil, white	20 kilos
Ceresin, white	5 kilos
Alkannin	15 grammes
Geranium oil, African	50 grammes
Palmarosa oil	30 grammes
Lemon oil	20 grammes

Herb Pomade.

Vaseline oil, yellow	20 kilos
Ceresin, yellow	5 kilos
Chlorophyl	20 grammes
Lemon oil	50 grammes
Clove oil	20 grammes
Geranium oil, African	12 grammes
Curled mint oil	4 grammes

Beef Marrow Pomade.

Vaseline oil, yellow	20 kilos
Ceresin, yellow	3 kilos
Beef marrow	2 kilos
Saffron substitute	15 grammes
Lemon oil	50 grammes
Bergamot oil	20 grammes
Clove oil	5 grammes
Lavender oil	10 grammes

China Pomade.

Vaseline oil, yellow	20 kilos
Ceresin, yellow	5 kilos
Brilliant, brown	12 grammes
Peru balsam	50 grammes
Lemon oil	5 grammes
Bergamot oil	5 grammes
Clove oil	5 grammes
Lavender oil	5 grammes

—Seifensieder Zeitung.

Solutions of Celluloid.—Celluloid dissolves in acetone, sulphuric ether, alcohol, oil of turpentine, benzine, amyl acetate, etc., alone, or in various combinations of these agents. The following are some proportions for solutions of celluloid:

1.	Celluloid	5 grammes
	Amyl acetate	16 grammes
	Acetone	16 grammes
	Sulphuric ether	16 grammes
2.	Celluloid	10 grammes
	Sulphuric ether	30 grammes
	Acetone	30 grammes
	Amyl acetate	30 grammes
	Camphor	3 grammes
3.	Celluloid	5 grammes
	Alcohol	50 grammes
	Camphor	5 grammes
4.	Celluloid	5 grammes
	Amyl acetate	50 grammes
5.	Celluloid	5 grammes
	Amyl acetate	25 grammes
	Acetone	25 grammes

—Neueste Erfindungen und Erfahrungen.

Wild Cherry Essence.—An "artificial" essence having the flavor of wild cherry and which may be used for flavoring wine, etc., is the following:

Acetic ether	5 fl. drachms
Benzoic ether	5 fl. drachms
Oenanthic ether	1 fl. drachm
Oil of bitter almonds (deprived of hydrocyanic acid)	2 fl. drachms
Saturated alcoholic solution of benzoic acid	1 fl. drachm
Glycerin	4 fl. drachms
Deodorized alcohol, enough to make	16 fl. ounces

Another formula which contains the fluid extract of wild cherry is this one:

Benzoic ether	1 fl. ounce
Oenanthic ether	2 fl. drachms
Amyl acetate	2 fl. drachms
Oil of bitter almonds (free from hydrocyanic acid)	1 fl. drachm
Fluid extract of wild cherry	3 fl. ounces
Glycerin	2 fl. ounces
Deodorized alcohol, enough to make	16 fl. ounces

—Pharm. Era.

Application for Mange in Dogs.—

Soft soap	4 parts
B-naphthol	1 part
Storax	2 parts
Tobacco extract	3 parts

To be applied to one-third of the skin at the most for three consecutive days. After three applications, wash the whole body with water in which ordinary carbolic acid soap has been dissolved.—Pharm. Era.

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Volume II contains much on the general subject of electricity, besides new articles of great importance. Among these the subject of alternate current machinery is treated. Wireless Telegraphy and Telephony receive attention. Electrical Measuring Instruments, The Electric Clock, The Telegraphone, Experiments in High Voltage, The Nernst Lamp, and Measuring the Heat of the Stars are all thoroughly illustrated and described.

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